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ETHNOLOGY.—*Linguistic history and ethnologic history in the Southwest.*[1]

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I

In the Southwest of the United States we find among the pueblos not only a considerable ethnological variety but also a very great linguistic diversity; and there are peripheral nonpueblo peoples. It is useful to try to correlate the various factors, in the light of archeological evidence, for the purpose of setting forth a testable set of hypotheses.

The pueblos show the following linguistic affinities:

Uto-Aztecan: Hopi (most closely related linguistically to Paviotso).

Zunian: Zuni (an isolated language that shows structural resemblance to Tanoan, and may be tentatively considered as distantly related to that family).

Tanoan:

- Tiwa (Taos, Picuris, Sandia, Isleta).
- Tewa (Santa Clara, San Juan, San Ildefonso, Nambe, Tesuque).
- Towa (Jemez).

Keresan:

- Western: Acoma, Laguna.
- Eastern: Santo Domingo, San Felipe, Santa Ana, Sia, Cochiti.

The extinct Pecos pueblo may have spoken Towa. Isleta del Sur was a colony of Isleta before it became hispanized, Pojoaque was Tewa-speaking, and the Piro and Tano of historic record were apparently Tiwa-speakers. Tanoan and Uto-Aztecan are related, being subdivisions of Azteco-Tanoan (see Whorf, B. L., and Trager, G. L., *The relationship of Uto-Aztecan and Tanoan*, Amer. Anthrop. **36**: 609–624. 1934). Zuni probably belongs here in some way. Keresan is almost certainly not related to these languages.

The nonpueblo peoples are: the Navahos and Apaches, who speak southern Athabascan languages; the Utes, Paiutes, Papago, Pima, Comanche, and Shoshoni, all of whom are Uto-Aztecan speakers; and to the east the Kiowa, the Caddo, and the extinct Texan tribes.

II

Ethnologically the pueblos are divided thus:

Western: Hopi and Zuni. These are the "typical" pueblos in social organization and orientation; there are matrilineal clans, a theocracy, the practice of restraint in all interpersonal relations and in personal attitudes, an avoidance of violence, dislike of leaders and leadership, no desire for "progress" as such.

Central: Acoma and Laguna. Here there are clans, but also an important moiety division. The theocracy is strong, and violence and excess are decried; but there are leaders within this frame, and often extremely violent reactions and behavior in resisting change or intrusion.

Eastern and Rio Grande: The eastern Keresans, and all the Tanoan pueblos. There are no clans, moieties exist but break down in function in Taos and Picuris; the theocracy is still strong but functions in terms of secular leaders; leadership is decried, but personal leaders arise constantly; violence is not infrequent. Taos shows plains influences.

[1] Portion of an address delivered before the Anthropological Society of Washington on May 15, 1951.

Archeologically the usual set-up for the region is about as follows (in very crude summary):

Anasazi (pueblo and pre-pueblo):

A.D. 100– 500 Basket Maker—earliest types of houses; no pottery.
500– 700 Modified Basket Maker—villages; pottery.
700– 900 Pueblo I—better houses; good pottery.
900–1050 Pueblo II—spread in area.
1050–1300 Pueblo III—period of greatest development.
1300–1700 Pueblo IV—"renaissance"—new techniques.
1700– Pueblo V—acculturation and change.

It is believed that the Athabascans (Navahos, Apaches) arrived after 1300, acquiring many pueblo traits thereafter.

When we compare the archeological remains known as Hohokam, there is seen to be a parallel and not too dissimilar development up to 1400, after which the culture disintegrates. The modern Pima may be descendents of the peoples of this group. In a similar way the Mogollon cultures rose and then fell after 1400.

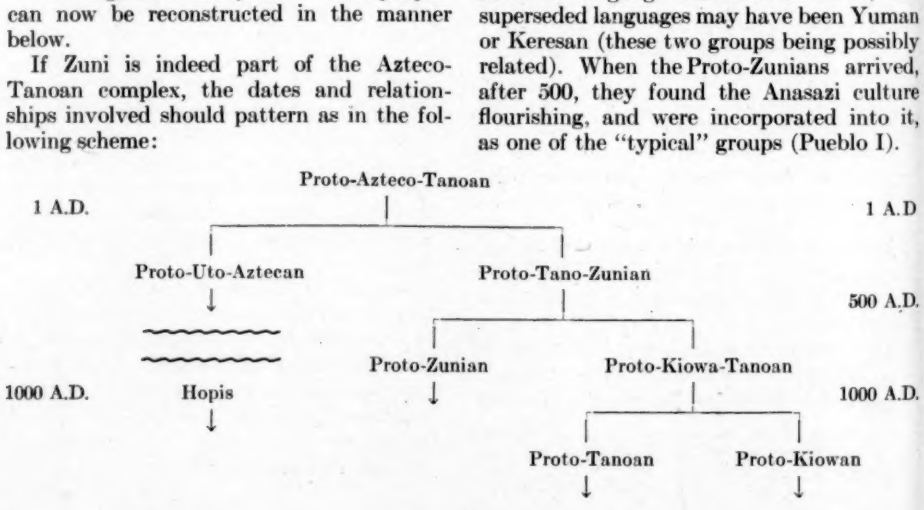
III

The linguistic history of all these peoples can now be reconstructed in the manner below.

If Zuni is indeed part of the Azteco-Tanoan complex, the dates and relationships involved should pattern as in the following scheme:

This LINGUISTIC scheme may be further elaborated by suggesting that the speakers of Proto-Azteco-Tanoan were living in the area north of what is now the Southwest. By the beginning of the Christian Era a part of them were moving south in large numbers. These developed the Proto-Uto-Aztecan language type, spreading quickly over the wide area, and reaching to central Mexico, with considerable linguistic proliferation and differentiation in the first few centuries of their movement. Some 500 years later, the stay-at-home Proto-Tano-Zunian speakers (the term is here used for the first time, to my knowledge) were afflicted by some urge to wander, and part of them went off. These reached the Southwest and made contact with the Modified Basket-Maker culture soon after leaving. The Proto-Kiowa-Tanoan speakers (another new term) remained behind, but after a few more centuries numbers of them separated from the main body and came into the Rio Grande area by 1000.

The Anasazi culture I conjecture to have developed among Keresan speakers. The impetus to its early development was possibly the coming of the Proto-Uto-Aztecan groups from the north, serving as a kind of a catalyst. The Uto-Aztecans themselves took over, perhaps, the more advanced cultures—pre-Hohokam and pre-Mogollon—that they found, and developed them, probably replacing the original languages by Uto-Aztecan languages of several kinds; the superseded languages may have been Yuman or Keresan (these two groups being possibly related). When the Proto-Zunians arrived, after 500, they found the Anasazi culture flourishing, and were incorporated into it, as one of the "typical" groups (Pueblo I).



By the time the Tanoan speakers came in, they simply took over or were absorbed by numerous Keresan-speaking Pueblo III groups.

The chart showed the Hopi appearing at about 1000. The closest linguistic relatives of the Hopi are the Paviotso, with a simple hunting and gathering culture. Possibly the Hopis represent the result of a late arrival by Uto-Aztecan speakers who took over in its totality a going Pueblo II or III culture. There are no other Uto-Aztecan speakers among the pueblos, and these pre-Hopis may have belonged to one of the cultures from a little further south that later disintegrated.

In summary, I conjecture pueblo culture as originating and developing among Keresan speakers. The specific Western Pueblo traits of Hopi and Zuni represent a flowering and development due to a kind of hybrid vigor; Zuni was probably there first, and the Hopis borrowed from it or took over a Zunilike culture. Finally the Tanoans came late, and some of them (the Northern Tiwa) never did develop some of the more usual pueblo traits.

IV

The linguistic time scale above is not very great but is probably long enough to allow for the variations that are found. The development as given does not contradict the known facts of archeology and ethnology. The important dates fit in rather well with other important developments.

The reconstruction of linguistic history shows that the Kiowa and Tanoan relationship is distant enough to suggest that it goes back to a point before the Tanoans had acquired pueblo culture, and when they were probably much as the Kiowa were before they developed specific plains traits in the nineteenth century.

Again, Zuni and the Tanoans are both pueblo in culture, but their linguistic relationship is such—if real—that it goes much farther back than that of Kiowa and Tanoan.

Finally, the Hopi are so placed linguistically that they must have got the rest of their present culture from some non-Uto-Aztecan, or at least non-Hopian, predecessors.

V

The problems presented by such a scheme as the foregoing are numerous and difficult. At least the following kinds of studies must be made to test the hypotheses. There must be extensive linguistic description of all the pueblo and peripheral languages, i.e., of the whole Azteco-Tanoan group. So far there exist only the following studies: Whorf on Hopi, Kennard's unpublished material on Hopi, Bunzel's grammar of Zuni (but there is no dictionary), my work on Taos (partly published), and my unpublished work on Picuris, Isleta, and Sandia; E. C. Trager's work on Kiowa (not yet completed), a few minor papers on Keresan, Boas's Laguna texts (unanalyzed, and with no dictionary), and the publications of Harrington on various phases of Tewa and Kiowa ethnology and language. These needed studies of the languages as structures must be followed by studies of the vocabularies and comparison all around, to see if it can be determined who borrowed from whom.

A further possibility is the examination of the vocabularies for all kinds of terms for material and nonmaterial aspects of the culture, to see which are more original or structurally basic, and thus establish the linguistic appurtenance of the people who devised the trait or complex.

Finally there is the possibility that metalinguistic (see Trager, G. L., *The field of linguistics*, Studies in Linguistics: Occasional Paper no. 1. 1949) studies may reveal whether one or another of the linguistic structures is in any way especially appropriate to the other cultural habits of the several peoples involved (see Whorf, B. L., Four articles on metalinguistics, Washington, D. C., Foreign Service Institute, Department of State, 1950, for the pioneer work in this field of linguistic 'Weltanschauung').

PALEONTOLOGY.—*New Western Hemisphere occurrences of fossil selachians.*[1]

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The specimens here described are among those fossil toothlike structures generally interpreted as rostral spines of pristid sharks. In particular, they are referable to the genera *Onchosaurus* Gervais and *Propristis* Dames. Obtained, respectively, from Ecuador and Georgia, they are of interest because neither genus seems to have been reported previously outside of Europe and North Africa; and the meager record of fossil pristids in the Western Hemisphere is raised, thus, to a total of six genera.[2]

The present specimens of *Onchosaurus* were transferred to the National Museum by the U. S. Geological Survey and those of *Propristis*, through the kind offices of S. C. Lyons, by the Georgia Kaolin Co. of Dry Branch, Ga. It is a pleasure to acknowledge with gratitude the cooperation of both of these organizations. The illustrations accompanying this note were prepared by William D. Crockett, scientific illustrator of the division of vertebrate paleontology, U. S. National Museum.

Onchosaurus cf. **radicalis** Gervais

This genus is represented by three fragmentary spines (U.S.N.M. nos. 18111, 18112, and 18113). The structures are strongly compressed, dorsoventrally. They presumably projected directly out from attachment along the lateral edge of a rostrum with little or no upward or downward flexure. They were, however, deflected posteriorly in a frontal plane as indicated by their convex anterior and concave posterior margins.

The teeth are composed, characteristically, of an exposed crown covered with smooth, unornamented enamel, and an unenamelled inserted root. Although no one crown among the present examples is entire, projection of the preserved edges shows this part to have had a triangular outline seen from either above or below, and to have occupied no more than one-third the longest axial dimension of the teeth. Proximally, at the anterior and posterior borders, the crown is slightly expanded to give an incipiently barbed appearance. Joining these barbs, the limit of enamel extends obliquely across the superior and inferior surfaces of the spine, arched in slight concavity toward the root. The free lateral edges of the crown are sharp.

In comparison with the reduced crown, the root portion of each spine comprises a notably long peduncle. This inserted part enlarges progressively from a thin, narrow distal neck adjacent to the crown to a maximum expansion at the proximal base. The peduncle is regularly ovate in section except near the base where the anterior and posterior margins are truncated. Here, the section is roughly quadrangular as is also the outline of the basal face. The sides of the root are marked by numerous coarse, alternating grooves and ridges which parallel the long axis of the spines. Those single anterior and posterior grooves are the most deeply incised but all are more pronounced proximally and tend to disappear distally. The furrows notch the circumference of the basal rim and are continuous with the ones radially arranged around the periphery of the shallow, elongate concavity occupying the proximal face of the root.

Measured in relation to its longest axis the best preserved spine (U.S.N.M. no. 18111, Fig. 1) possesses the following dimensions: total preserved length, 43.5 mm.; anterior height of root, 31.0; posterior height of root, 38.5; proximal width of root, 21.5; distal width of root, 11.5; proximal maximum thickness of root, 13.5; and distal minimum thickness of root, 6.0.

Geological horizon and locality.—Collected from the Upper Cretaceous (Turonian) on the left bank of the Rio Napo, one-fourth mile upstream from the village of Napo, Province of Oriente, Ecuador, by Joseph H. Sinclair and Theron Wasson, 1923.

Remarks.—The systematic and stratigraphic history of all the so-called ganopristine sharks was recently reviewed by Arambourg (1940). As treated therein, two subgeneric groups assigned a total of six previously described species from

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] The four genera of fossil pristids previously reported occurring in the Western Hemisphere are *Ischyrhiza* Leidy, *Onchopristis* Stromer, *Pristis* Linck, and *Schizorhiza* Weiler (cf. DUNKLE, Journ. Washington Acad. Sci. **38**: 173–176. 1948; HAY, Carnegie Inst. Washington Publ. 390: 603–604, 719. 1929; LOFGREN and OLIVIERA, Bol. Div. Geol. Misc., Rio de Janeiro, **106**. 1943; ROMER, *Vertebrate paleontology*, ed. 2: 577. 1945; and WETZEL, Palaeontographica **73**: 94–97. 1930).

various Upper Cretaceous horizons were defined and referred to the genus *Onchosaurus*. Specifically, there are: (1) a subgenus *Onchosaurus* s. str. containing the species *radicalis* Gervais (1852) and *pharao* Dames (1887); and (2) a subgenus *Ischyrhiza* with the species *mirus* Leidy (1856a), *antiquus* Leidy (1856b), *stromeri* Checchia-Rispoli (1933), and *marocconus* Arambourg (1935).

It will be noted that the above references include various departures from the usages originally given some of these generic and specific names. The six species assigned to *Onchosaurus*, like the majority of other ganopristine forms, are based upon unassociated rostral spines. Stromer (1917, 1925, and 1927) has demonstrated wide variation in size and structure between individual teeth of the related and more adequately known sawfish, *Onchopristis*. It appears possible, therefore, that future discoveries of more complete remains of *Onchosaurus* may prove the changes in taxonomic concept proposed by Arambourg (1940) to have been premature. The attempted revision, however, serves an extremely useful basis for comparison, and in this connec-

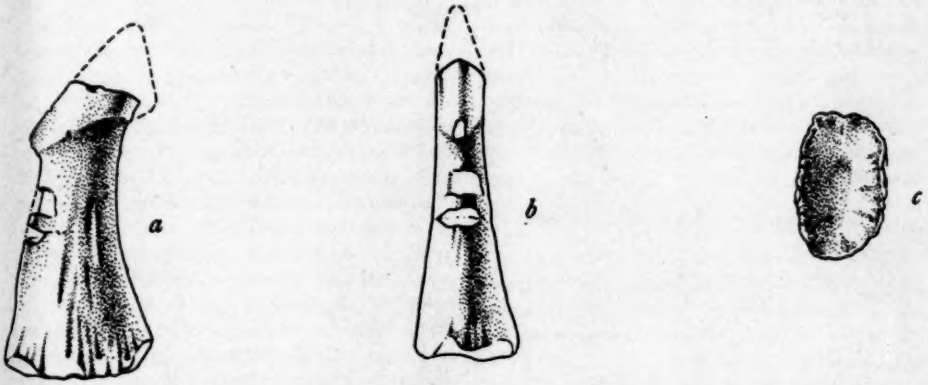

FIG. 1.—*Onchosaurus* cf. *radicalis* Gervais (U.S.N.M. no. 18111): Rostral spine from the Upper Cretaceous (Turonian) of Ecuador in (*a*) dorsal or ventral, (*b*) anterior, and (*c*) basal aspects. Approx. × 1.

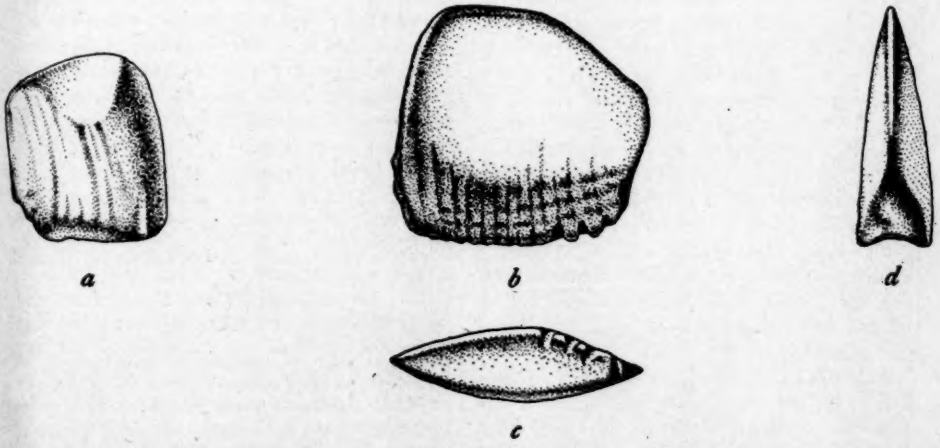

FIG. 2.—*Propristis* cf. *schweinfurthi* Dames: Rostral teeth from the upper Eocene (Jackson) of Georgia: (*a*) (U.S.N.M. no. 18216) in dorsal or ventral view; and (*b*, *c*, *d*) (U.S.N.M. no. 18215), respectively, in dorsal or ventral, basal, and anterior aspects. Approx. × 2.

tion, the presently recorded spines from Ecuador clearly pertain to the subgenus *Onchosaurus* s. str. Further, they agree in most essential details with specimens identified as *radicalis* and lacking the flattened and axially grooved posterior root border characteristic of *pharao*, are tentatively referred to the former, genotypic species.

Individually the six referred members of the genus *Onchosaurus* are relatively restricted, stratigraphically, but collectively, they comprise a typical Upper Cretaceous assemblage, ranging from the Cenomanian to the Danian. The species *radicalis* has been reported from just two Senonian localities in France. The Ecuadorian specimens were collected with fragmentary materials of *Squatina* sp., *Acrotemna faba*, and indeterminate shark vertebrae and a pycnodontid tooth plate. The Turonian age of these vertebrate remains was established upon associated invertebrate fossils identified by Reeside (in Wasson and Sinclair, 1927).

Propristis cf. **schweinfurthi** Dames

Two unassociated but well-preserved specimens (U.S.N.M. nos. 18216 and 18215, illustrated in Fig. 2), exhibit the basic characteristics of all the rostral spines previously assigned to this particular fossil sawfish.

Both teeth are strongly compressed, dorsoventrally, and viewed from either above or below, present irregularly quadrangular outlines. The forward border of each is the shortest of the four margins. Straight or even slightly concave in profile, this forward edge is flattened into a triangular area with broad, rugose proximal base tapering to a sharp distal apex. The entirely carinate posterior margin is weakly convex in profile and is the longest dimension exhibited by the teeth. From dorsal or ventral view, the basal margin is similarly convex, and the elliptical face of this inserted part is occupied by a shallow elongate concavity whose surface is roughened with the numerous openings of pores. The distal, exposed margin is in rounded confluence with both the anterior and posterior edges, and is rounded and polished smooth, apparently from functional wear.

Enamel as a tooth cap is absent. In consequence, the external textural appearance of the spines is reminiscent of that of the rostral teeth of *Pristis*. The upper and lower surfaces are marked by alternating low ribs and shallow grooves paralleling the longitudinal axes of the structures. These are crossed by less distinct transverse ridges which tend to converge from the posterior border toward the anterior edge. Like the comparable markings on the bases of *Onchosaurus* spines, these features are more deeply pronounced on the proximal surfaces and disappear distally.

Measured in relation to the longest axes, the specimens have the following dimensions: greatest over-all length, 18.5 and 14.0 mm.; maximum over-all width, 20.25 and 13.25; width of base, 16.5 and 9.5; maximum thickness of base 5.5 and 4.5.

Geological horizon and locality.—Collected from strata of upper Eocene (Barnwell or lower Jackson) age exposed in quarries of the Georgia Kaolin Co. near Dry Branch, Twiggs County, Ga., by S. C. Lyons, 1948.

Remarks.—The two unassociated rostral spines of *Propristis* from Georgia can not be distinguished with certainty from those of the North African *P. schweinfurthi* and hence are referred to that species (Fraas, 1907).

These North American examples were found associated with other vertebrate remains, namely: teeth of *Carcharias*, *Isurus*, *Myliobatis*, and *Sphraena;* and fragments of the carapace and plastron of the turtle *Amyda*. The source horizon of this faunule is a stratum of sand and fullers earth immediately overlying the extensively quarried Tuscaloosa kaolins. According to a recently published stratigraphic section (La Moreaux, 1946), measured in the quarries of the Georgia Kaolin Co. in Twiggs County, this sediment may be assumed to be of lower Jackson age. In consequence a slight extension of the known range of *Propristis* is indicated since the genus has been reported only from the middle Eocene of Birket el Qurun, Egypt.

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ENTOMOLOGY.—*Phylogeny and biogeography of the caddisflies of the genera* Agapetus *and* Electragapetus (Trichoptera: Rhyacophilidae).[1]

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An analysis of the phylogeny and distribution pattern of the small caddisflies belonging to the genus *Agapetus* and its allies has presented some interesting data on the movement of faunal elements between North America and Eurasia. For insects the time relations of this entire phase of distribution is poorly understood, although there is evidence in most groups of crossings between the parts of Holarctica. In the *Agapetus* group there is some evidence for placing such crossings in relation to geologic time.

The results of this study of the *Agapetus* line attest the fact that many small insect genera occupy a unique place in unraveling the phylogeny and morphogenetic steps in a large number of groups. This has been stressed by Emerson (1950) in his remarks on the objectivity of monotypic genera. In many instances these small genera are surviving members of early points in phyletic lines that have developed abundant faunas specialized far beyond these relicts. We are justified in regarding such archaic survivors as living fossils. In insect studies they are what we must use as a basis for phylogenetic deduction in theoretical areas of evolutionary speculation. In groups such as vertebrates and Mollusca, fossil evidence is used in this capacity.

It is my conviction that, by and large, insect groups possess more living fossils than vertebrate groups do true fossils and that, as a consequence, the entomologist has an unusual opportunity to contribute material basic to the study of biogeography and evolution.

Electragapetus is one of those archaic genera of which, fortunately, we have available both a well-preserved fossil and two existing species. Its study establishes the order of origin of the distinctive characters of *Agapetus* and allows the dating of at least part of the associated phylogenetic development. With this as a basis a preliminary analysis has been attempted of the origin, divergence, and dispersal of the entire *Agapetus* complex.

THE AGAPETUS LINE

The genus *Agapetus* represents a phyletic line (Fig. 15) that arose from the genus *Anagapetus* and that is characterized in the adult primarily by a reduction and reorganization of the veins of the hind wing. The apex of development in these characters occurs in the *fuscipes* complex of the genus *Agapetus*.

In *Anagapetus* the front wing (Fig. 1) is much like *Rhyacophila*. The hind wing is also little changed from the primitive rhyacophilid type; its radial field (Fig. 6) has all branches present and the forks of R_s occur before cross-vein *s*; and the anal veins are all present, with 1A and 2A forming an elongate fork. The genus *Catagapetus* represents the first steps toward *Agapetus*. In *Catagapetus* the front wing has lost vein R_{1a}, and cross-vein *r* has become aligned with cross-vein *s* (as in Fig. 2); and in the hind wing (Fig. 7) cross-vein *s* has moved basad. Existing species show reductions of hind wing venation that have occurred in the *Catagapetus* line since it separated from the main *Agapetus* stem.

In *Electragapetus* (Fig. 8) the first major steps in specialization are seen: fork R_{2+3} has migrated

[1] This paper is a joint contribution from the Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey, and the Department of Entomology, University of Illinois.

close to the margin of the wing, fork R_{4+5} has migrated a short distance in the same direction, and cross-vein *s* has migrated closer to the basal fork of R_s. The more primitive existing species of *Agapetus*, such as the species *dubitans*, exhibit a marked change in this hind wing pattern (Fig. 9). Beyond cross-vein *r*, R_1 is reduced to a short, oblique section fusing with Sc; the basal part of R_1, *r*, and R_{2+3} beyond *r*, have realigned to form a serial vein with a slight dip on the part of the vein composed of *r*; cross-vein *s* has completely disappeared; and R_{4+5} branches much closer to the wing margin. This early point in *Agapetus* development is called the *Synagapetus* stage, and its origin is labeled *S.S.* in Fig. 15.

Between the *Electragapetus* stage and the *Agapetus* stage of evolution of the radial veins, a second development of the hind wing venation took place. In *Anagapetus* and *Electragapetus* (Fig. 6) vein 3A is short and free, running into the margin of the wing. In *Agapetus* (Fig. 9) it appears to have turned up at the end and run into vein 2A just beyond cross-vein *a*. The short stub projecting from the curved connection, however, may actually be the tip of 3A and the connecting portion may be an adventitious spur or branch that has developed as a cross brace. Following this interpretation, when the stub is present it is labeled 3A and the connecting piece 3A′; when the stub is absent the vein is labeled simply 3A.

After the change began in the anal veins, reduction still continued in the anterior veins, involving first a complete loss of the oblique section of R_1 running from *r* to Sc, and then both a coalescence of Sc with the anterior margin, and continued movement of the forks of R_s toward the wing margin. The end of this direct line is represented by the European *fuscipes* (Fig. 13) in which all but the base of Sc has coalesced with the anterior margin, fork R_{2+3} has become completely obliterated, and fork R_{4+5} is very close to the wing margin. Throughout this series little change occurs in the front wing or in the anal region of the hind wing. This sequence of reduction of venation has proceeded independently in several distinct phyletic lines within *Agapetus*, and reached various stages in different lines.

A somewhat similar situation exists regarding the male genitalia in the *Agapetus* complex. From at least the origin of *Electragapetus*, the ancestral form of genitalia has had single segmented clasp-

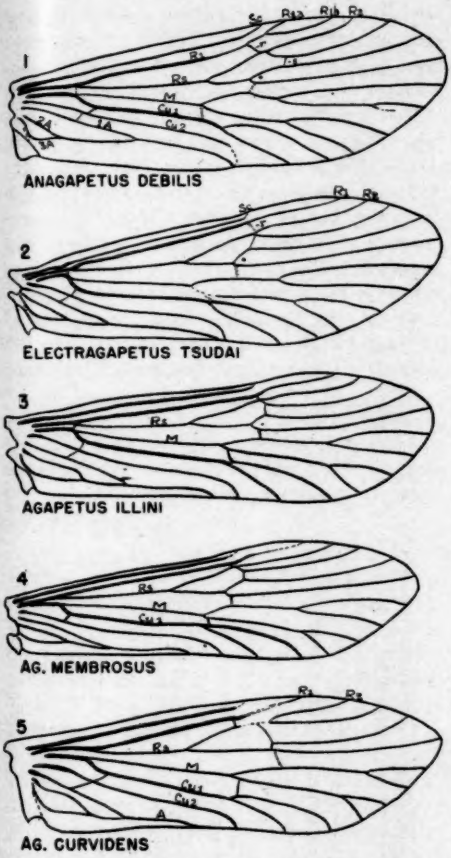
ers, the tenth tergite divided into a pair of vertical, platelike, and only partially sclerotized lobes, and at the base of each lobe a fingerlike, projecting cercus bearing an irregular row of long setae (Fig. 23A). Differences in genitalia between most of the species involve chiefly differences of proportion or addition of ornamentation to this general basic type. That is, in one species the tenth tergite may be long, in another species short; or in one species the clasper may have a mesal spur, in another none. In certain lines, however, there is a marked reduction of the cercus, and in a few lines this structure has completely disappeared. Judged from evidence from other structures, the same modifications have arisen independently in different lines.

PHYLETIC BRANCHES OF AGAPETUS

Evidence indicating the first major division of *Agapetus* is found in a curious pair of organs occurring one on each lateral portion of the fifth sternite of the males. In some species this organ is internal and forms an oval or round cavity opening by a narrow slit to the outside. Its function is probably olfactory or auditory. Beginnings of this organ are found in some of the primitive species placed in the subgenus *Synagapetus*, such as *dubitans* and especially *iridipennis*, in which an invagination is present beneath a ridge on the side of the fifth sternite. The organ is present as a well-developed structure in many of the European species and all the American species, but absent in all the Japanese and East Pacific Island species I have seen.

This latter group of Oriental species thus appears to be an independent evolutionary line, starting from a primitive species of *Synagapetus* representing a stage before the lateral male organ had begun to develop. The genitalia have remained primitive in essential respects throughout the line, but the hind wing venation has become progressively reduced to the condition found in *curvidens* (Fig. 14) in which not only radius but also the branches of media are greatly reduced. This complex of species I am calling the *curvidens* line.

The other species in *Agapetus* form a line also stemming from a primitive *Synagapetus* type, but a line which branched into several subsidiary developments. One of them culminated in the *membrosus* complex, another in the relatively primitive *comatus* complex, a third in the *fuscipes*

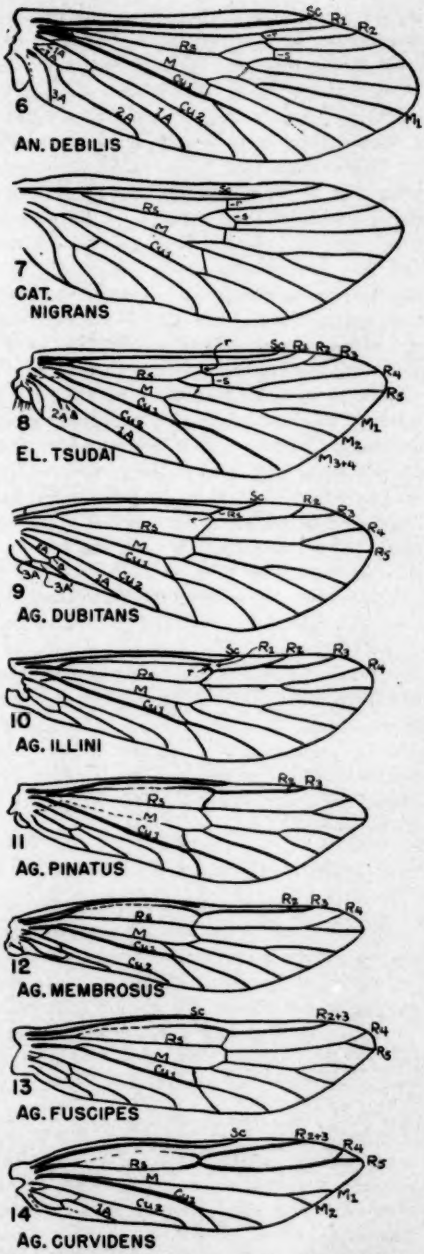


FIGS. 1–5.—Front wings of the *Agapetus* line.

complex, these three apparently confined entirely to Eurasia, and a fourth which gave rise to the American species of *Agapetus*.

There are other lines that I am unable to place phylogenetically in satisfactory fashion but that probably originated as close relatives of the *comatus* group. These include the following, tentatively considered as subgenera of *Agapetus* until detailed study allows more exact treatment: *Myspoleo* Barnard, from South Africa; *Afragapetus* Mosely, from the mountains of east-central Africa; *Allagapetus* Martynov, from Turkestan and India; and *Lanagapetus* Mosely, from Madeira.

The American species exhibit two circumstances suggesting their position in relation to the Eurasian fauna. In the first place, although



FIGS. 6–14.—Hind wings of the *Agapetus* line: Ag., *Agapetus;* An, *Anagapetus;* Cat., *Catagapetus;* El., *Electragapetus.* (Fig. 7 after McLachlan; Fig. 9 after Mosely.)

the American fauna contains many diverse types of genitalia, they appear to be related to each other rather than to various known complexes of the Eurasian fauna. In the second place, the base of the various lines begins with forms having a relatively primitive hind wing venation (Fig. 10) little changed from the primitive *Synagapetus* wing (Fig. 9). This indicates that the American fauna probably arose from a single ancestor which crossed from Eurasia to North America, and that this ancestor was a primitive form of the *Agapetus* branch which developed the lateral male organ. None of the American species have undergone a great deal of evolution as regards venation. The primitive species such as *boulderensis* and *illini* have in the hind wing a faint trace of the base of R_1 (Fig. 10) and definite angulations where *r* joins R_1 and R_{2+3} and in the males a fairly long cell R_2. The most specialized wings differ only in that the serial radial vein has become smoother in the region of *r*, all trace of R_1 beyond this point is lost, and cell R_2 is short in both sexes (Fig. 11).

The relationships of the genera and the known lines of *Agapetus* are shown in Fig. 15. This chart shows the few specialized lines of *Agapetus* actually studied, and in addition an approximation of the origin of the African lines. While the nature of the lateral male organ is not known for the African species, the venation and male genitalia are relatively generalized and indicate that these arose from a form essentially like that persisting in the *comatus* line.

BIOGEOGRAPHY

With the exception of the Baltic amber *Electragapetus scitulus*, the data for biogeographical analysis of the group under discussion consist entirely of the known distribution patterns of existing species. These patterns are fragmentary for many species, but nonetheless they bring out certain points that should furnish at least a starting point for needed further study in this field.

Judged from the habitat or climatic preference of all existing species, the group is and always has been restricted to clear, cold, small streams or brooks. The only exception is the subgenus *Tagapetus*, which probably inhabits warmer streams than is typical for other species. This cold-adapted characteristic of the group means that all spreading of range occurred only through territory where such streams were relatively numerous. For range extensions from Eurasia into Africa, a mountain highway would have been imperative in order to afford these stream conditions through the equatorial belt.

The ancestral genus *Anagapetus* is quite successful in many montane localities in North America in competition with both *Glossosoma* and *Agapetus*. From this it would seem probable that if it had ever occurred in Eurasia, some remnant of it would still survive and have been found. On the same grounds of competitive behavior, the genera *Catagapetus* and *Electragapetus* may be ascribed to an existence confined to Eurasia. Since this constitutes our only evidence, I am following it as a general precept.

DISPERSAL AND EVOLUTIONARY LINES

The *Catagapetus-Agapetus* line (Fig. 15) probably started in late Cretaceous or early Cenozoic time as a population of *Anagapetus* which spread

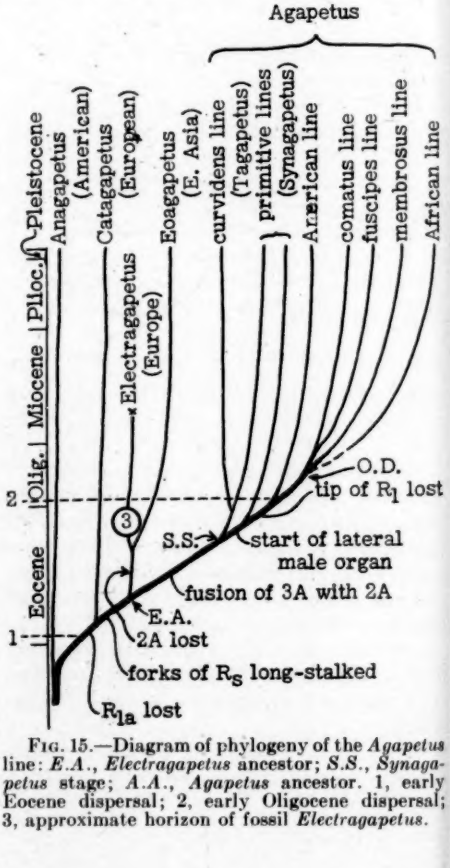


FIG. 15.—Diagram of phylogeny of the *Agapetus* line: *E.A.*, *Electragapetus* ancestor; *S.S.*, *Synagapetus* stage; *A.A.*, *Agapetus* ancestor. 1, early Eocene dispersal; 2, early Oligocene dispersal; 3, approximate horizon of fossil *Electragapetus*.

from North America into Eurasia. This gave rise first to a *Catagapetus*-like form differing in only a few morphological respects from its progenitor. From this form arose a more modified form, in which the hind wing underwent reduction of venation and produced a form much like *Electragapetus*, but retaining all of vein 2A in the hind wing. This, the Electragapetus Ancestor, must have become widespread, divided, and had its parts isolated geographically, for it gave rise to two distinct phyletic lines, leading to *Electragapetus* and *Agapetus*, respectively.

The *Electragapetus* line remained very like its ancestor, changing only slightly in venation. It had developed into a definitive *Electragapetus* morphotype by late Eocene or early Oligocene, and it is a matter of record in the Baltic amber that it occurred at this time in the vicinity of Germany. Eventually its range embraced all Eurasia, as witnessed by living species in eastern Siberia and Japan.

The *Agapetus* line underwent continued reduction in hind wing venation, and reached the *Synagapetus* stage before a successful, long range, competitive form was evolved. This type also became widespread over Eurasia, with existing species having primitive types of genitalia surviving in China, India, and many areas in Europe, and more specialized species in Japan and Madeira. There is one record, based on a female specimen, from northern Ontario, Canada, which may indicate a spread of the group through northern North America, but pending knowledge of the male no interpretation of this record will be attempted.

This primitive *Synagapetus* group gave rise to a line that may have become isolated in the islands to the east of the Asiatic coast. Its only known members are now recorded only from Japan, the Philippine Islands, Java, and New Guinea. The line has undergone much change, culminating in the *curvidens* complex.

Other *Synagapetus* stock developed a curious lateral organ on the fifth sternite of the male. After this development there occurred a spread of the line throughout continental Eurasia and into North America and possibly also Africa. Each of these extensions of range is represented today by an isolated and frequently highly distinctive group. From this it seems certain that after the range extension occurred, most of the avenues of dispersal became ecologically unsuitable for *Agapetus* and have remained so since.

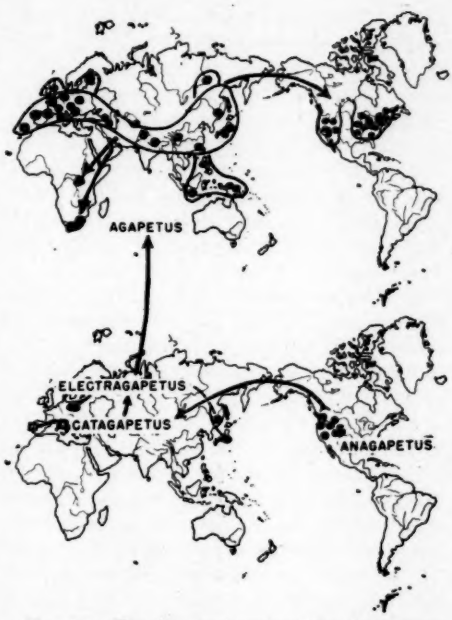


FIG. 16.—The dispersal cycle of the *Anagapetus* to *Agapetus* evolutionary line. In the upper map the present distribution pattern of the generalized species of *Agapetus* (chiefly *Synagapetus*) is diagrammed as the sinuate oval across Eurasia.

Otherwise we would expect a mingling of diverse faunal units in the periphery of the range of the group. It is likely that this radiation was made possible by the extensive orogenies culminating in the Miocene, which provided avenues of dispersal across the old sea Tethys and gave rise to the African mountains and many of the extensive ranges in southern Europe and Asia.

The retention of the stub of R_1 in the hind wing of primitive American species indicates that this line resulted from a population which spread into North America before the European and African progenitors had evolved. The monophyletic nature of the existing American fauna indicates that no later dispersals occurred from Asia, and the Asiatic fauna indicates that no American forms spread back to Asia.

TIME RELATIONSHIPS

The problem of fixing the evolutionary sequence in Fig. 15 calls for a matching of known or inferred time of events based on information from the *Agapetus* data with possible dispersal opportunities deduced from studies of other

groups. In this latter connection I have drawn chiefly on the summary of Holarctic mammal dispersal given by Simpson (1947).

The Oligocene Baltic amber fossil *Electragapetus* provides us with one approach to the dating problem. Referring to Fig. 15, we see that—

1. There must have existed an ancestor common to both *Electragapetus* and *Agapetus*, which possessed a hind wing like Fig. 8 but which retained vein 2A, still preserved in *Agapetus*. This ancestor is indicated as E. A. in Fig. 15.

2. The *Electragapetus* line lost 2A. The time which elapsed during this loss represents the time interval between E. A. and the formation of the generic characteristics of *Electragapetus* as it appears in Oligocene amber and today. There is no evidence to indicate how far this occurred up the *Electragapetus* line, so in Fig. 15 this must first be placed arbitrarily as an indeterminate period. It is highly likely that the *Electragapetus* line continued as a viable, primitive line for some time after the separation of *Eoagapetus*. The assumed point of extinction of the *Electragapetus* line is terminated by an "x." This point is purely arbitrary.

3. In the fossil *Electragapetus* hind wing, vein 2A is atrophied to cross-vein *a*. In subgenus *Eoagapetus* there is still a vestige of this vein. On this evidence, the division between the two occurred before early Oligocene from which the fossil is known. This places the time of E. A. as definitely pre-Oligocene and further places the time of the spread of *Anagapetus* into Eurasia as considerably before Oligocene.

Another suggested dating occurs at point O. D. (Old World dispersal of *Agapetus*). Shortly after the spread of *Agapetus* to North America (morphologically speaking) there occurred a dispersal of *Agapetus* to the various mountainous regions of southern Eurasia and Africa. Since Africa is involved, this spread could hardly have occurred prior to the shrinkage of Tethys in the Miocene; it is also likely that suitable mountain habitats were not available in Africa and parts of southern Eurasia until the orogenies producing the shrinkage of Tethys had progressed to an advanced stage. It is also apparent that following the spread of a primitive *Agapetus* there was an isolation of populations in various areas, an isolation that has persisted to the present. During this period each isolate has developed into a distinctive taxonomic entity.

Turning to evidence that Simpson (1947) has assembled from distribution of mammalian fossils, there is found a remarkably close correlation with certain conclusions. Simpson postulates that (1) there was a relatively complete interchange of American and Eurasian forms in early Eocene, (2) a lesser but extensive interchange in early Oligocene, and (3) small interchanges of only limited ecological types until late Pliocene. Although Pliocene and Pleistocene interchanges were not made by *Agapetus*, the first two points fit very well with the analysis made of the genus.

Evidence from the phylogeny of the Rhyacophilidae (Ross, 1951) gives every reason to believe that *Anagapetus* had evolved by middle or late Cretaceous. It could have spread into Eurasia on an early Eocene bridge, and the Eurasian isolate start on the evolutionary road to *Agapetus*. If this time of crossing is correct, the Eurasian line evolved fairly rapidly through ancestral *Catagapetus* and *Electragapetus* stages and past the early *Agapetus* stage (that is, *Synagapetus*) before Oligocene. Presumably the specialized *Agapetus* line had just begun to evolve when a species of its early complex spread into North America and then was cut off on this continent. The slightly more specialized European continuation of the line spread in Miocene to its present outposts.

This explanation satisfies the conditions that E. A. be pre-Oligocene, and that O. D. be late Oligocene or Miocene. Beyond these limits, of course, the branchings in Fig. 15 are simply "reasonable estimates."

One question arising from this explanation is of more than usual interest. When *Agapetus* spread into North America, why did not *Catagapetus* and/or *Electragapetus* spread with it? They were both extant somewhere in Eurasia at that time. It is quite possible that they may yet be found in North America, for many mountain regions of the Northwest are virtually uncollected; or they may have made an entry and the colony become extinct. It is also possible that these two genera were confined to Europe or Western Asia during early Oligocene. A third and highly plausible alternative is that *Agapetus* had developed an ecological tolerance for warmer streams than the other two, and that in the Oligocene conditions on the Bering bridge were opportune for *Agapetus* but not for the others.

TAXONOMIC NOTES

Certain of the deductions made in the preceding pages are based on new species, which are described below. Unless otherwise stated, types are in the collection of the Illinois Natural History Survey.

Genus **Electragapetus** Ulmer

This genus was described to include a single fossil species, *scitulus* Ulmer, from Baltic amber. Later Martynov described the genus *Eoagapetus* to receive a living species, *praeteritus* Martynov, from eastern Siberia. The venation of the two is virtually identical, the differences between the two groups being mainly in male genitalia. This relationship seems best expressed by considering the two groups as subgenera, as follows:

Cercus digitate, projecting free from narrow base, similar to condition shown in Fig. 21A
Electragapetus

Cercus low, with basal attached portion very long, apical edge with a row of fine setae, Fig. 17A
Eoagapetus

Subgenus **Eoagapetus** Martynov

KEY TO SPECIES

Lobes of tenth tergite symmetrical, each with a short lateral point at tip; cercus evenly crescent shaped; clasper with apical margin notched to produce a wide dorsal and very narrow ventral lobe..... **praeteritus** Martynov

Lobes of tenth tergite asymmetrical, right lobe inconspicuous and membranous, left lobe sclerotized and with its ventral angle produced into a long slender finger; cercus with ventral portion larger than dorsal; clasper simple, Fig. 17..... **tsudai,** n. sp.

Electragapetus tsudai, n. sp.

Many characters of the genitalia differentiate this species from *praeteritus,* summarized in the preceding couplet.

Male.—Length 8 mm. Color dark brown, legs and venter slightly lighter than dorsal portion. General structure, including wing venation, Figs. 2 and 8, typical for genus. Fifth abdominal sternite with only slightly embossed lateral areas. Genitalia as in Fig. 17. Tenth tergite with right lobe membranous and inconspicuous, left lobe with ventral corner digitate and long, angled both ventrad and laterad. Cercus forming a short but very deep flap, extending ventrad over the base of the clasper. Clasper with lateral aspect regular, rounded at apex, and nearly twice as long as deep; both upper and lower margins have a sclerotized tooth a third distance from apex. Aedeagus very long, with a pair of long sclerotized rods, one flattened and convoluted before the spinelike apex, the other slender, more rounded, and nearly straight.

Holotype.—Male; Higashiyama, Fukushima Pref., Japan, May 24, 1949, Mrs. M. Kohno.

Paratype.—Yu River, Higashiyama, Kita-aizu-gun, Fukushima Pref., May 24, 1949, Mrs. M. Kohno.

Genus **Agapetus** Leach

Arriving at a workable classification for this genus has been difficult. While the species resolve into separate phyletic lines, the primitive members of a line sometimes differ little from members of unspecialized lines, but the end species of the line may be radically different from any other species in the genus. It is desirable to make special subgeneric categories for the very unusual forms, yet it seems impractical to make a separate subgenus for every phyletic line.

Subgenus **Synagapetus** McLachlan

To this subgenus authors have usually referred species in which hind wing R_1 joins Sc, Fig. 9, and the female middle tibiae are dilated. It is now apparent that this simple definition is in need of revision, but a more thorough understanding of the genus is required to reach a satisfactory result. For purposes of the present I am considering *Synagapetus* as a broad unit, including species previously placed in *Synagapetus* and *Pseudagapetus,* and a third group having hind wing R_1 lost at its tip but with no male lateral organ. This latter group includes *japonicus* Tsuda, and three New Guinea species described here. At the evolutionary apex of the line stand the Philippine species *curvidens* Ulmer (Fig. 14) and the Java species *abbreviatus* Ulmer. These two are so distinct from other members of their line that they have evidently come under the influence of new, strong selection pressures and started a divergent branch of their own. A new subgenus is therefore erected for their reception.

Agapetus ulmeri, n. sp.

The very simple male genitalia and venation indicate this as one of the primitive members of the genus. The angulate anterior margin of the ninth segment, however, in this and the two

following species indicates that they are offshoots from the base of the *curvidens* line. The short, truncate tenth tergite lobes combined with the slender clasper differentiate this species from its relatives.

Male.—Length 3.5 mm. Color dark brown, the legs and venter slightly lighter. General structure typical for genus, venation similar to that of *illini* female, but the hind wing with no vestige of the tip of R_1 and with no pronounced dip in the R_1 serial vein at *r*. Front tibia with inner apical spur much shorter than outer, both fairly small. Fifth abdominal sternite with simple embossed area. Genitalia as in Fig. 19. Ninth segment with anterior margin broadly but fairly sharply angulate. Lobes of tenth tergite deep and short, truncate at apex, and each with a dorso-lateral flange above cercus. Cercus fingerlike, with four long setae. Clasper simple, the apical portion narrowed, straight, and without sclerotized points. Aedeagus with simple rods sharply upcurved at apex.

Holotype.—Male; Hollandia, New Guinea, rain forest, March 22, 1945, H. Hoogstraal.

Agapetus jafiwi, n. sp.

This species is most closely related to the preceding, from which it differs in the shape of the tenth tergite lobes and the produced anterior margin of the ninth segment.

Male.—Length 4 mm. Color and general structure, including wing venation and fifth abdominal segment, as in the preceding species. Genitalia as in Fig. 20. Ninth segment fairly long both dorsad and ventrad, its anterior margin produced into a long internal projection with a pointed apex. Tenth tergite with each lobe fairly long and deep, with a recurved, small, dorsal hook and the extreme apex also forming a hooklike projection. Cercus short and stout, with four long setae. Clasper long, with base only moderately wide, apex pointed, and with a pointed ventromesal flap just before the apex.

Holotype.—Male; Hollandia, New Guinea, March 15, 1945, at light, near Jafiwi, H. Hoogstraal.

Agapetus latosus, n. sp.

The tenth tergite lobes in this species have a most curious shelflike lateral overhang which is unlike anything else illustrated in the genus. Other characters, especially the produced ninth segment and simple clasper, indicate that this is another member of the *curvidens* line.

Male.—Length 3.5 mm. Color, general structure, venation, and characters of the fifth abdominal sternites as for the preceding species. Genitalia as in Fig. 22. Ninth segment narrow dorsad, longer than usual ventrad, the anterior margin produced into a large, triangloid, rounded projection. Tenth tergite lobes deep at base, with a lateral, irregularly serrate overhang; the apex of each lobe forms a triangular, slightly downcurved piece the base of which fits under the lateral overhang. Cercus elongate and slender, with four setae on apical third, its dorsal aspect appearing a little bulbous at base. Clasper with lateral aspect short, parallel sided and rounded at apex; ventral aspect with a mesal point at apex, and with basal half wide. Aedeagus with simple rods.

Holotype.—Male; Doromena, Netherlands New Guinea, February 25, 1945, Hoogstraal and Jewett.

Paratypes.—Same data, 2 ♂.

Tagapetus, n. subg.

Characteristics.—General structure of head and body typical for genus. Diagnostic differences in venation are as follows: front wing (Fig. 5) with fork R_{4+5} very narrow, and cross-vein *s* long, so that vein R_4 is much closer to R_5 than to R_3, and with both forks of M close to margin of wing; hind wing (Fig. 14) with Sc distinct from margin, the two principal radial veins very close together at center of wing, and vein M_{3+4} and cross-vein *m-cu* entirely atrophied; in addition the hind wing has R_{2+3} unbranched, R_{4+5} with a very short branch, and apex of 2A reduced to an indistinct stub.

Genotype.—*Agapetus curvidens* Ulmer.

In addition to the genotype, *Tagapetus* includes *abbreviatus* Ulmer from Java.

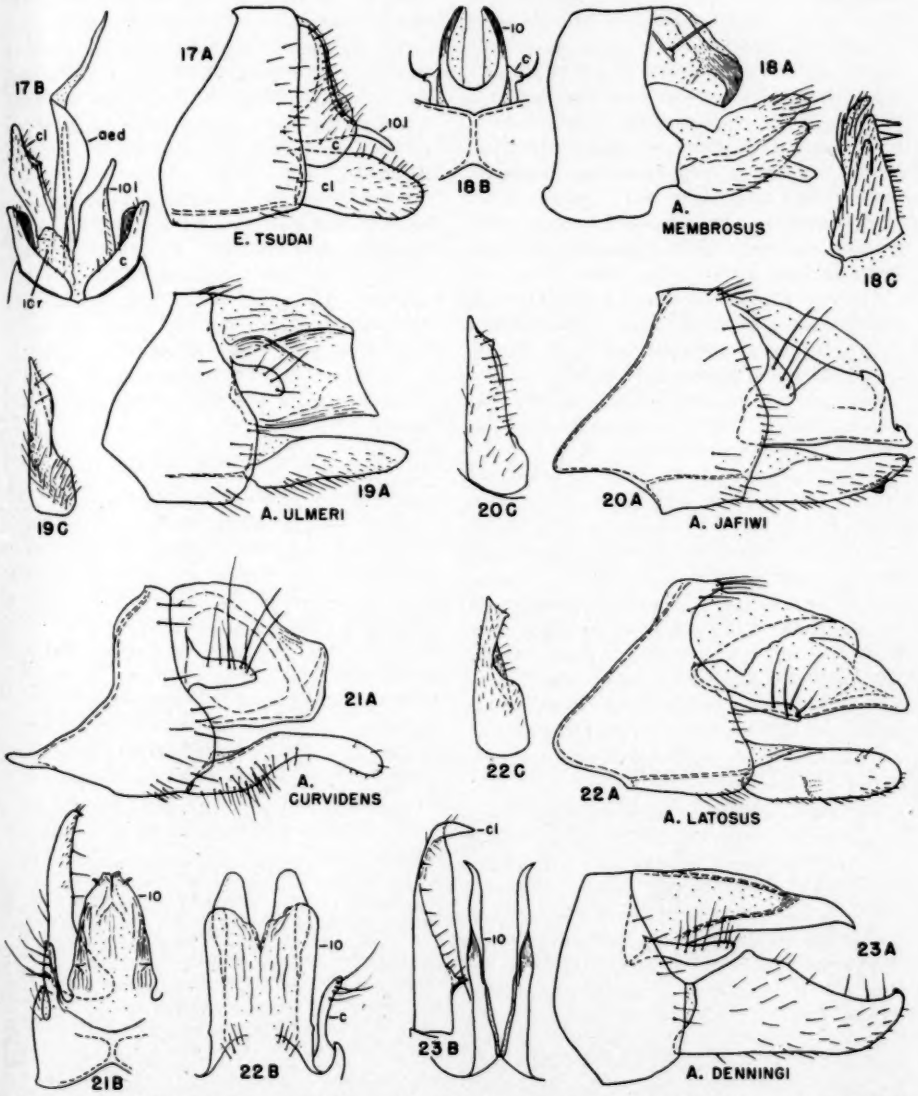
The male genitalia of the genotype (Fig. 21) exhibit many characteristics of the generalized type, with the addition of the slender, elongate and sinuate clasper and the anterior sharp projection of the ninth segment. These characters of genitalia leave no doubt but that *curvidens* is one of the end products of its phyletic line. The unusually great differences in wing venation also indicate clearly that the two species in the subgenus have undergone very rapid evolution compared to all other members of their line.

Subgenus **Agapetus** Leach

The subgenus *Agapetus* is defined here as the general group in which the tip of R_1 is atrophied in the hind wing, and the lateral abdominal organ of the male is well developed as a round or ovoid internal structure.

Agapetus membrosus, n. sp.

This species is one of the end branches of the *membrosus* line, differing from the *bidens* group in having the apexes of both the clasper and membranous dorsal lobe blunt rather than sharp and pointed. In addition the ventral spur of the



FIGS. 17–23.—Male genitalia of *Electragapetus* (*E.*) and *Agapetus* (*A.*): A, Lateral aspect; B, dorsal aspect; C, ventral aspect of clasper. (*aed*, aedeagus; *c*, cercus; *cl*, clasper; *l*, left lobe; *r*, right lobe.)

clasper is short in *membrosus*, long and pointed in the *bidens* group.

Male.—Length 3 mm. Color dark brown, nearly black, the venter and legs slightly lighter. General structure typical for genus. Hind wing, Fig. 12, with Sc close to but slightly separated from margin; R_{2+3} with minute branch at extreme apex; anal veins with base of 2A and apex of 1A forming a straight serial vein, beneath which is a single loop of doubtful composition (see discussion above for *membrosus* group). Fifth sternite with lateral areas embossed. Genitalia as in Fig. 18. Tenth tergite divided into a pair of stout, curved arms. Cercus represented by a thin strap embedded in membrane, the end of the strap with a single long seta. Clasper with a short, triangular main piece with a dorsal membranous lobe and a ventral truncate projection. Aedeagus with simple rods.

Female.—Length 3.5 mm. Color and general structure as in male. Middle legs with tibia and basitarsus expanded, foliaceous, and concave mesad. Abdomen slender and pointed.

Holotype.—Male; Unlong-kong (above), Szechwan, China, 12,000–15,000 feet elevation, July 3, 1929, H. Stevens.

Allotype.—Female; Tu-pa-keo, Szechwan, China, 7,400 feet elevation, September 3, 1929, H. Stevens.

Paratypes.—All from Szechwan, China, H. Stevens: same data as for holotype, 2 ♂; same data as for allotype, 1 ♀; same as for allotype, but September 5, 2 ♂; between Shuang-yo and Tu-pa-keo, August 30, 1929, 1 ♂. Holotype, allotype, and three paratypes in the Chicago Natural History Museum; three paratypes in the collection of the Illinois Natural History Survey.

Agapetus denningi, n. sp.

The genitalia indicate that this species belongs to the small complex including *ophionis* Ross and *taho* Ross and is an especially close relative of *taho*. From this species, *denningi* differs in having a more triangular lateral aspect of the clasper and an almost even dorsal outline of the tenth tergite, which ends in a simple, downcurved point. It is likely that *denningi* represents a condition close to that of the ancestor of the complex.

Male.—Length 5 mm. Color dark brown, slightly lighter on legs and venter. General structure typical for genus, and for subgenus as described above. Genitalia as in Fig. 23. Ninth segment nearly annular, with anterior margin evenly bowed. Tenth tergite with lobes bladelike and thin, each with lateral aspect fairly shallow, triangular, elonate, and ending in a sclerotized portion which is curved ventrad and beaklike. Cercus moderately long and slender, with an irregular row of long setae. Clasper with base massive, apex tapering to a point curved sharply mesad; at the dorsal apex of the basal portion is a short, sharp projection pointed mesad. Aedeagus with simple rods.

Female.—Size, color, and general structure as for male. Female characters typical for *ophionis* complex, for which means of specific separation in this sex are not yet known.

Types.—Holotype, male, Rouge River National Forest, Oreg. Allotype, female, and paratype, male, same data. Holotype and allotype in the collection of D. G. Denning, paratype in the collection of the Illinois Natural History Survey.

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HERPETOLOGY.—*Studies on the lizard family Xantusiidae, II: Geographical variation in* Xantusia riversiana *from the Channel Islands of California.* JAY M. SAVAGE, Natural History Museum, Stanford University. (Communicated by F. J. Hermann.)

While studying the Baja California night lizards of the species *Xantusia vigilis* (Savage, 1951), I examined the two supposed subspecies of the island night lizard, *Xantusia riversiana*, in an attempt to determine what characters might be of value in delimiting subspecies within the genus. Preliminary inspection revealed that the characters used to differentiate the two nominal subspecies of *riversiana* were apparently so subject to individual variation and personal interpretation that doubt was cast upon the value of sub-dividing the species.

Xantusia riversiana was described by Cope (1883, p. 29) as the second known species of the genus. Since that time the species has been found to be endemic to San Nicolas, Santa Barbara, and San Clemente Islands in the southern group of Channel Islands off the coast of southern California. The restricted range and structural homogeneity of the island night lizards has caused most authors to regard all three insular colonies as forming a single population. Dr. Hobart M. Smith (1946, p. 292) was the first seriously to question this concept. He proposed that the San Clemente Island colony should be recognized as a distinct subspecies, *X. riversiana reticulata*. His conclusions were derived from an examination of one specimen from San Clemente Island and three examples from San Nicolas Island, the type locality of *X. r. riversiana*.

Smith would differentiate the two nominal subspecies on the basis of the following characteristics: *riversiana*—(1) preanal scales large, regular; (2) central gular scales somewhat enlarged; (3) pregular fold well defined; (4) sutures between head scales clearly apparent, although some pits present; (5) a distinct dorsolateral light streak on each side; (6) dorsal pattern less distinctly marked with dark; *reticulata*—(1) preanal scales small, irregular; (2) central gular scales nearly uniform, scarcely enlarged medially; (3) pregular fold poorly defined; (4) head plates exceedingly pitted, corrugated and broken up; (5) no dorsolateral light line; (6) dorsal pattern reticulated and spotted with black.

ANALYSIS OF CHARACTERISTICS

The taxonomic value of several of these characteristics (size of gulars, nature of pregular fold, and coloration) might immediately be questioned by anyone familiar with variation in xantusiid lizards. Others of the supposed diagnostic characters would at first glance seem to be useful in the definition of subspecies in this family (size and number of preanals and nature of head scalation). In order to discover the normal range of variation and determine those differences of systematic significance, an analysis of each of Smith's criteria was undertaken in a relatively large sample of island night lizards. Comparison and study of 24 specimens from San Nicolas Island, 11 from Santa Barbara Island, and 61 from San Clemente Island have supplied the information presented below and represent, I believe, an adequate summary of the variation of these characteristics.

Preanals.—The preanal scales are basically six in number, large and arranged in three transverse rows. Considerable breaking up of these scales occurs in some individuals, and the condition may vary from the regular 6-scaled type through innumerable intermediates until as many as 18 small, irregular scales are present. The majority of specimens in this sample had seven to nine preanal scales. Fisher (1936, p. 175) illustrates a similar variability in a large sample of the mainland species, *X. vigilis vigilis*.

Obviously, when applying Smith's terms "large, regular" and "small, irregular" to this character, it was necessary to set rather arbitrary limits as to what constituted these two categories. When the preanals were maintained in a condition approaching a regular series of large, unbroken scales they have been recorded as "large." Those lizards with the preanal scales fragmented into a large number of small, irregularly shaped scales have been included under "small." Utilizing these definitions the nature of the preanal scales and the percentage composition of each type in the three insular populations is given in Table 1.

TABLE 1.—VARIATION IN PREANAL SCALES

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Large, regular	8	33	1	9	20	33	29	30
Small, irregular	16	67	10	91	41	67	67	70
Totals	24	100	11	100	61	100	96	100

An examination of Table 1 shows that the presence of "large" preanal scales is consistently low in all three island populations. San Clemente and San Nicolas Island specimens are almost identical in the percentage composition of large and small preanals and cannot be separated on the basis of this character. No significant difference exists between these two samples and the series from Santa Barbara Island. The apparent discrepancy in the percentage composition between this latter group of lizards and those from the other two islands is probably attributable to the small size of the Santa Barbara sample.

Actually the splitting up of the preanal scales is probably not the result of any genetic factor but of a developmental change produced by some environmental influence during early ontogeny. Similar environmental effects have been shown to influence scutullation in snakes (Fox, 1948, p. 252) and in turtles (Lynn and Ullrich, 1950, p. 253). If environmental factors are responsible, the slight differences observed between Santa Barbara Island lizards and the series from other islands could not be considered of systematic value as a significant difference would only be a reflection of ecological effects upon the development of the sample. Obviously the nature of the preanal scales in island night lizards is of no taxonomic value and cannot be accepted as a criterion for distinguishing subspecies.

Gular scales.—The difference in the relative size of the median gular scales, as used by Smith, is of such a fine qualitative distinction as to be almost impossible to apply. As pointed out by Fisher (1936, p. 174) in the related night lizard, *X. v. vigilis*, the number of enlarged scales on the gular fold is subject to wide variation. In *X. riversiana* the size of the gulars as well as the number is quite variable. It is true that some individuals appear to have the two median gular scales somewhat larger than their fellows but just where to draw the line between gulars "scarcely enlarged medially" and gulars that are "somewhat enlarged" presents a problem. It was necessary for tabulation that some sort of decision as to what constitutes these two categories be made. I have therefore included under the "enlarged" group only those examples having the central gular scales very definitely larger than those adjacent to them. Frankly, I do not feel that even this method is valid in determining the size of the gulars, and independent examination of several series at different times confirms this suspicion. A sample of specimens from each island was examined by me on four different occasions. Upon each one of these occasions a different number of "enlarged" examples was recognized. To make matters worse, examples classified as "large" on one occasion would be grouped with "scarcely enlarged" the next time the samples were examined. Apparently the character is so variable that a clear-cut decision cannot be made as to which group, "enlarged" or "scarcely enlarged," any given individual belongs.

The results of the analysis of this characteristic, utilizing the methods of determination explained above, are presented in Table 2. San Clemente lizards are almost constant in having the median scales enlarged. The small Santa Barbara series has more enlarged than uniform examples and the San Nicolas specimens are almost evenly divided between the two types. It might be argued that the San Clemente Island population could be separated from the other two colonies on the basis of this character. However, at least 50 percent of the San Nicolas and Santa Barbara specimens would fall into the same category as San Clemente examples. The high percentage of "enlarged" gulars listed for the San Clemente sample may actually be the result of bias on my part. These specimens were the first lizards examined in the study when I was not too adept at distinguishing between the two supposed types of gulars. Consequently it is probable that a re-

TABLE 2.—VARIATION IN SIZE OF GULAR SCALES

	San Nicholas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Enlarged	14	58	9	82	60	98	83	86
Uniform	10	42	2	18	1	2	13	14
Totals	24	100	11	100	61	100	96	100

examination of the San Clemente series would result in slightly different groupings. These facts coupled with the difficulties already emphasized in determining the nature of the gular scale character forces the rejection of this characteristic as a systematic aid.

Pregular fold.—All *Xantusia* possess two more or less well-developed pregular folds. The posterior fold is usually well marked and lies only a few scales anterior to the gular fold. The anterior pregular fold extends from the base of the auricular aperture on one side across the throat to the opposite ear opening and is usually poorly developed or absent in the live animal. It is this latter fold which is used by Smith to characterize his two subspecies of *X. riversiana*. Unfortunately, Smith did not have enough material to ascertain that the anterior pregular fold is often absent in living material and usually appears only as the result of preservation. In my experience, the anterior pregular fold is often distorted and frequently not visible even subsequent to preservation. Consequently, the separation of two populations on the basis of the presence or absence of this fold seems impossible.

Table 3 represents the presence or absence of the anterior pregular fold in a series of unevenly preserved specimens. The table is nothing but an account of the manner in which these lizards were preserved and is included to make it obvious that even if this character were not due to the mode of preservation no really significant differences occur between the various colonies. The San Nicolas sample is somewhat isolated in the relative proportions of the two types of fold but this is probably the result of the fact that the majority of the San Nicolas examples are from a single collection and were all preserved in a similar manner. The pregular difference is thus of absolutely no significance in *X. riversiana*.

Pitting of the head shields.—Table 4 shows that the number of individuals from each sample with the head shields so pitted as to completely obscure the sutures between the shields is relatively small. The character appears to be correlated with the age of the specimen, for the head shields are broken up in all large examples regardless of locality and the smaller specimens lack excessive pittings. The pits are present on all lizards examined although difficult to find on a number of small examples. They appear to be the openings of integumentary "glands" similar in some respects to the femoral pores. Apparently these

TABLE 3.—VARIATION IN PREGULAR FOLD

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Well defined	9	37	7	64	47	77	63	66
Poorly defined	15	63	4	36	14	23	33	34
Totals	24	100	11	100	61	100	96	100

TABLE 4.—VARIATION IN STRUCTURE OF HEAD SHIELDS

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Broken up	0	0	2	18	6	10	8	8
Smooth	24	100	9	82	55	90	88	92
Totals	24	100	11	100	61	100	96	100

pits grow at a constant rate throughout life and, after the general growth rate of the lizard begins to slow down at maturity, the pits continue to expand and eventually succeed in completely deforming the usual configuration of the head shields. No geographic correlation of a sufficient magnitude to warrant a separation of one insular colony from another is indicated by the distribution of this character. San Nicolas Island examples lack broken up head shields but this is probably the fault of the sample which consists almost entirely of moderate-sized lizards. This character must also be rejected as a means of delimiting subpopulations of *X. riversiana*.

Dorsal coloration.—The dorsal pattern of these lizards is usually a gray, brownish or cream ground-color upon which is superimposed a series of reticulated longitudinal bands. These bands vary in color from light brown to black and are sometimes coalesced to form two rigidly delimited dorsolateral dark stripes and a single well-defined dorsal band. The ground color between these stripes or bands appears as two light spaces. In extreme specimens possessing these dorsolateral light stripes the upper margins of the dark dorsolateral stripes and lower margins of the middorsal stripe are heavily pigmented so that the light interspace is sharply defined. This is the condition assumed by Smith to be typical of San Nicolas Island night lizards. All sorts of

intermediates between the reticulate pattern and the lined phase occur within any single population. All young examples tend to be more or less striped in appearance but the most prominently striped specimens are mature individuals.

Taking the lizards with light lines well defined and bordered by a dark stripe as being "lined" and all other lizards as being "unlined," I prepared Table 5. The complete absence of striped individuals in the Santa Barbara series is most likely due to the small sample size. San Nicolas Island and San Clemente Island colonies are close in relative percentage composition of the two color phases. The character is obviously worthless as a means of separating the various island populations. It may be that the extreme lined phase is the product of a single recessive allele although the observed frequencies of lined forms are somewhat lower than might be expected on the basis of such a hypothesis.

It is notable that Dr. George S. Myers, of Stanford University, reports that he took both lined and unlined phases side by side under the same debris on San Clemente Island. Kenneth S. Norris, of the Scripps Institution of Oceanography, informs me of the same condition occurring on San Nicolas Island.

Other characters.—An analysis of scale counts and measurements reveals no significant differences between the three insular populations. Data on these counts and a complete redescription of the island night lizard are reserved for a projected monograph of the Xantusiidae.

TABLE 5.—VARIATION IN OCCURRENCE OF DORSOLATERAL LIGHT LINES

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Lined	5	21	0	0	6	10	11	11
No lines	19	79	11	100	55	90	85	89
Totals	24	100	11	100	61	100	96	100

CONCLUSIONS

None of the characteristics employed by Smith to define his subspecies of *X. riversiana* are of value in separating the various island colonies. One character (preanals) is perhaps the result of environmental effects, another (gular scales) is a matter of individual interpretation, a third (pregular fold) reflects the mode of preservation, a fourth (pitting of the head shields) is probably ontogenetic in nature, and the last (dorsal coloration) appears to be due to normal genetic variation. Since none of these characteristics can be utilized in defining subpopulations of the island night lizard, it follows that the name *X. riversiana reticulata* must be relegated to the synonymy of *X. riversiana*. This action is taken in the hope that it will avert further use of the name in the literature (Schwenkmeyer, 1949; Shaw, 1949; Knowlton, 1949) and prevent the recognition of a systematically nonexistent entity.

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MAMMALOGY.—*Six new mammals from the state of San Luis Potosí, Mexico.* WALTER W. DALQUEST, Louisiana State University Museum of Zoology, Baton Rouge, La. (Communicated by Herbert Friedmann.)

Among the many specimens acquired in the course of recent distributional studies of mammals conducted by Louisiana State University in the Mexican state of San Luis Potosí, there is material that represents a new species and five undescribed subspecies. These new forms are described here in advance of a more extensive account dealing with the mammals of San Luis Potosí as a whole. I am indebted to Hartley H. T. Jackson and Stanley P. Young, of the United States Fish and Wildlife Service, and to David H. Johnson and Henry W. Setzer, of the United States National Museum, for the loan of comparative material. Localities mentioned in the following accounts, unless otherwise specified, are in the state of San Luis Potosí; measurements are in millimeters; and capitalized color terms are from Ridgway (Color Standards and Color Nomenclature, Washington, D. C., 1912).

Thomomys umbrinus newmani, n. subsp.

Type.—Adult female, skin and skull no. 4193, Louisiana State University Museum of Zoology; obtained 7 km northwest of Palma (village 12 km northwest of Salinas), San Luis Potosí, México, by Walter W. Dalquest on August 8, 1950; original number, 14537.

Range.—Known only from the desert plains near the city of Salinas in western San Luis Potosí.

Description.—A very small pocket gopher, total length 200 mm or less; condylobasal length less than 35 mm; males larger than females; skull small, smooth, relatively narrow; color pale, soft, near Sayal Brown above with the middorsal area scarcely darker, near Cinnamon-Brown; underparts pale gray to Light Pinkish Cinnamon.

Comparisons.—*Thomomys umbrinus newmani* is one of the smallest races of the species. It is distinctly smaller than *T. u. atrodorsalis* Nelson and Goldman from the mountains southeast of the city of San Luis Potosí, *T. u. zacatecae* Nelson and Goldman from southeastern Zacatecas, *T. u. supernus* Nelson and Goldman from central Guanajuato, or *T. u. enixus* Nelson and Goldman from the Sierra Moroni of southern Zacatecas. *T. u. potosinus* Nelson and Goldman is similar to *newmani* in size but is much darker in color. All the above-mentioned races are darker than *newmani* except the large *T. u. zacatecae*, which, though richer in color, resembles *newmani* in lacking the distinct black or blackish wash in the middorsal area.

Measurements.—The arithmetic means for two adult male and three adult female topotypes are, respectively: Total length, 192, 185; length of tail, 61, 60; length of hind foot, 26, 26; height of ear from notch, 5, 5; condylobasal length (from occipital condyles to anteriormost edge of incisors), 33.6, 33.3; length of diastema, 12.4, 11.7; length of maxillary tooth row, 7.1, 6.9; zygomatic breadth, 21.6, 21.8; interorbital breadth, 6.4, 6.4; mastoid breadth, 18.3, 17.6; greatest crown breadth across upper molar rows, 6.9, 6.8.

Remarks.—This subspecies is named for Robert J. Newman, who obtained numerous specimens of mammals in the state of San Luis Potosí and who helped to obtain the specimens here listed.

Specimens examined.—Total number, 6, from: 7 km northwest of Palma, 5; Cerro Peñon Blanco, 1.

Thomomys umbrinus arriagensis, n. subsp.

Type.—Adult male, skin and skull no. 5075, Louisiana State University Museum of Zoology; obtained 1 km south of Arriaga, San Luis Potosí, México, by Walter W. Dalquest on September 22, 1950; original number, 14780.

Range.—Known only from the type locality on the Plan de Arriaga, a small, high, arid plain near the Guanajuato boundary southwest of the city of San Luis Potosí.

Description.—A medium-sized pocket gopher but one of the largest of the central-Mexican races of *Thomomys umbrinus*; condylobasal length of adults more than 41 mm; skull large with flaring zygomatic arches; colors dull and ashy; middorsal area usually heavily washed with blackish; sides Sayal Brown to Cinnamon; underparts Drab.

Comparisons.—None of the subspecies of *Thomomys umbrinus* whose geographic ranges approach that of *T. u. arriagensis* is as large as *arriagensis*, has such flaring zygomatic arches, or

is as dull and ashy in color. The nearest races, geographically, are *newmani* and *potosinus*, two of the smallest races of the species. The larger forms, *atrodorsalis*, *zacatecae*, *enixus*, and *supernus*, are all much smaller than *arriagensis*. Specimens of *T. u. crassidens* Nelson and Goldman from western Zacatecas have not been examined, but judged from the original description this race is much brighter in color than *arriagensis* though it may approach it in size.

Measurements.—The arithmetic means for four male and six female topotypes are, respectively: Total length, 219, 202; length of tail, 65, 62; length of hind foot, 28, 27; height of ear from notch, 6, 6; condylobasal length, 41.3, 37.9; length of diastema, 15.8, 14.1; length of maxillary tooth row, 8.0, 7.7; zygomatic breadth, 26.2, 24.5; interorbital breadth, 6.7, 6.6; mastoid breadth, 20.2, 19.6; greatest crown breadth across upper molar rows, 7.7, 7.6.

Specimens examined.—Total number, 10, all from the type locality.

Perognathus penicillatus atrodorsalis, n. subsp.

Type.—Adult male, skin and skull no. 5226, Louisiana State University Museum of Zoology; obtained 7 km west of Presa de Guadalupe, San Luis Potosí, México, by Walter W. Dalquest on October 12, 1950; original number, 15109.

Range.—Desert plains of the central part of the state of San Luis Potosí from the western base of the Sierra Madre Oriental westward at least to the type locality. A related subspecies, *P. p. eremicus*, is found in northern San Luis Potosí, north and west of the city of Matehuala.

Description.—A medium-sized, slim-bodied pocket mouse with crested tail longer than head and body; lacking long, stiff spines in pelage of rump area; color of upperparts near Avellaneous mixed with black, with middorsal area, and sometimes the entire dorsal area, heavily washed with black or blackish.

Comparison.—The only subspecies of *Perognathus penicillatus* whose geographic range approaches that of *atrodorsalis* is *P. p. eremicus* Mearns. The heavy black wash on the back of *atrodorsalis*, present in all but a very few individuals, is sufficient to distinguish *atrodorsalis* from *eremicus*.

Measurements.—The arithmetic means for nine adult males and twelve adult females, all from the vicinity of the type locality, are, respectively: Total length, 168, 163; length of tail, 92, 89; length of hind foot, 22, 22; height of ear from notch, 8, 8; greatest length of skull, 24.8, 24.6; condylobasal length, 21.1, 21.0; length of maxillary tooth row, 3.4, 3.4; zygomatic breadth, 13.1, 12.8; interorbital breadth, 6.1, 6.3; mastoid breadth, 12.3, 12.1; greatest crown breadth across upper molar rows, 4.4, 4.3.

Remarks.—Seemingly no collector of mammals has previously visited the desert plains of central San Luis Potosí where this race of *Perognathus penicillatus* is found and where the species seems to reach it southernmost limit of distribution.

Specimens examined.—Total number, 36, from: 7 km west of Presa de Guadalupe, 9; Presa de Guadalupe, 23 (10 skulls only); 7 km southeast of Presa de Guadalupe, 2; 16 km northwest of Ciudad del Maíz, 2.

Perognathus lineatus, n. sp.

LINED POCKET MOUSE

Type.—Adult male, skin and skull no. 5253, Louisiana State University Museum of Zoology; obtained 1 km south of Arriaga, San Luis Potosí, México, by Walter W. Dalquest on September 21, 1950; original number, 14734.

Range.—The desert plains of western and central San Luis Potosí and, doubtlessly, adjacent parts of Guanajuato, Zacetecas, and Jalisco.

Description.—A medium-sized, slim-bodied pocket mouse, with a crested tail longer than head and body, and lacking long, stiff spines in the pelage of the rump area; color of upperparts dull gray, finely but distinctly lined with buffy, especially on head; general appearance of upperparts near Light Drab or Drab Gray; sides more grayish; underparts white separated from gray of sides by faint, indistinct line of pale buffy; tail dusky above and white beneath.

Comparisons.—*Perognathus lineatus* differs from *P. n. nelsoni* Merriam in its distinctive coloration and the absence of long, stiff spines in the pelage of the rump area, but it resembles *nelsoni* in size, proportions, and cranial characters. Among the species of pocket mice that lack spines in the rump area, *lineatus* most closely resembles *penicillatus* but differs from at least the geographically adjacent races of that species in its distinctive coloration, larger size, and larger, broader skull. *Perognathus lineatus* has been taken in the same trap lines with both *P. penicillatus* and *P. nelsoni*.

Measurements.—The arithmetic means for eight males and seven females are, respectively: Total length, 174, 174; length of tail, 95, 98; length of hind foot, 23, 23; height of ear from notch, 8, 8; greatest length of skull, 25.4, 25.4; condylobasal length, 21.8, 21.5; length of maxillary tooth row, 3.6, 3.8; zygomatic breadth, 13.1, 13.1; interorbital breadth, 6.3, 6.3; mastoid breadth, 12.7, 12.5; greatest crown breadth across upper molar rows, 4.6, 4.6.

Specimens examined.—Total number, 29, from: Cerro Peñon Blanco, 6; 6 km south of Matehuala, 1; 1 km south of Arriaga, 13; Bledos, 8 (1 skull only); 10 km northwest of Villar, 1.

Oryzomys alfaroi huastecae, n. subsp.

Type.—Adult male, skin and skull no. 5436, Louisiana State University Museum of Zoology; obtained 10 km east of Platanito, San Luis Potosí, México, by Walter W. Dalquest on November 13, 1950; original number, 15643.

Range.—The tropical, eastern slopes of the Sierra Madre Oriental in eastern San Luis Potosí.

Description.—A small, slim-bodied, long-tailed, dark-colored rice rat; total length about 200 mm; tail slim and nearly naked; claws of hind feet nearly concealed by long, white bristles; color of upperparts Bister to Snuff Brown; sides slightly paler than back; ears black; underparts whitish or pale gray; tail dusky above and only slightly paler beneath.

Comparisons.—This subspecies is similar in size to *Oryzomys alfaroi chapmani* Thomas but is paler and browner in color. Young animals especially are less blackish than the young of other races of *Oryzomys alfaroi*. Compared with its nearest geographic neighbor, *O. a. dilutior* Merriam, *huastecae* is smaller and has a smaller, relatively narrower skull.

Measurements.—The arithmetic means for four adult males and two adult females are, respectively: Total length, 196, 202; length of tail, 101, 110; length of hind foot, 26, 25; height of ear from notch, 17, 17; greatest length of skull, 26.9, 27.0; condylobasal length, 23.6, 23.8; length of maxillary tooth row, 4.1, 3.7; length of palatal bridge, 4.9, 5.2; zygomatic breadth, 13.7, 13.6; interorbital breadth, 4.6, 4.6; mastoid breadth, 11.1, 10.7; greatest crown breadth across upper molar rows, 5.0, 5.1.

Remarks.—The discovery of this race of *Oryzomys alfaroi* extends the known range of the species northward from Huachinango, in central Puebla, to eastern San Luis Potosí. It doubtlessly extends northward also into Tamaulipas, for specimens were taken a few miles from the boundary of that state.

Specimens examined.—Total number, 14, from: 10 km east of Platanito, 9 (2 skulls only); Xilitla, 2; Cerro Miramar (near Xilitla), 1; Cerro San Antonio (near Xilitla), 2.

Neotoma ferruginea griseoventer, n. subsp.

Type.—Adult female, skin and skull no. 3194, Louisiana State University Museum of Zoology; obtained at Xilitla, San Luis Potosí, México, by Marcella Newman on June 27, 1947; original number, M 29.

Range.—Known only from El Salto and Xilitla on the tropical, eastern slopes of the Sierra Madre Oriental in San Luis Potosí.

Description.—A large, coarsely-furred wood rat; first upper molar with anterointernal reentrant angle deep, reaching more than half way across anterior lobe; fur of underparts plumbeous with only faint wash of white and entirely lacking white at the bases of the hairs; color of upperparts in fresh pelage dark brown, Prout's Brown on sides and near Sepia on back; underparts Drab Gray with nearly complete pectoral band of dull Pinkish Cinnamon; feet silvery white; tail sharply bicolored, blackish above and white beneath.

Comparisons.—*Neotoma f. griseoventer* resembles *N. f. torquata* Ward but is larger, with larger skull and darker color, especially beneath. It most closely resembles *N. f. distincta* Bangs, from the tropical slopes of the Sierra Madre Oriental in Veracruz, but has smaller molar teeth, a more slender rostrum, and is less reddish in color. The gray underparts of *N. f. griseoventer* seem to be unique in this genus.

Measurements.—External measurements of the type, an adult female, are: Total length, 392; length of tail, 175; length of hind foot, 42; height of ear from notch (dry), 26. Cranial measurements of a male from El Salto, a male from Xilitla, and the type, are, respectively: greatest length of skull, 48.3, 47.6, 46.6; condylobasal length, 44.9, 45.9, 43.7; basilar length, 37.7, 40.3, 37.5; length of maxillary tooth row, 9.1, 9.5, 9.8; length of nasals, 17.4, 18.2, 17.5; length of incisive foramina, 10.5, 10.5, 8.9; zygomatic breadth, 24.1, 25.0, 22.6; interorbital breadth, 5.7, 5.5, 5.9; mastoid breadth, 18.6, 19.2, 17.4; rostral breadth, 7.7, 7.6, 8.0.

Remarks.—*Neotoma ferruginea* has an extensive

geographic range over the southern part of the Mexican Plateau, and in some areas it has extended its range over the lip of the plateau and into the upper edge of the tropical zone on the slopes of the Sierra Madre. Populations in the Tropics have become isolated and have evolved into strongly differentiated races. *Neotoma f. griseoventer* would seem to represent another such race were it not for the fact that no wood rats of the *ferruginea* type have been reported from the Mexican Plateau of San Luis Potosí or from the lowlands to the east. Presumably *ferruginea* once occurred in the desert ranges of western San Luis Potosí. The known distribution of *griseoventer* suggests that it was derived from a population of those wood rats that extended their range over the Sierra Madre and into the tropics. It is highly unlikely that the tropical rats of San Luis Potosí are directly connected with the tropical rats of Veracruz (*N. f. distincta*) along the entire length of the Sierra Madre Oriental. The wood rats of the Sierra Madre of San Luis Potosí seem to be a relic population isolated far to the north of the remainder of the range of the species.

Specimens examined.—Total number, 3, from: El Salto, 1; Xilitla, 2.

ORNITHOLOGY.—*The systematic relationships of the fox sparrows* (Passerella iliaca) *of the Wasatch Mountains, Utah, and the Great Basin.* WILLIAM H. BEHLE and ROBERT K. SELANDER, Museum of Zoology, University of Utah. (Communicated by Herbert Friedmann.)

While discussing the subspecies *Passerella iliaca schistacea* in his revision of the genus, Swarth (Univ. California Publ. Zool. **21**: 155.1920) commented that the race, even as he restricted it, probably covered a composite of two or more recognizable subspecies. This remark was probably prompted by differences that he detected between examples from Canada and northern Nevada. He did not have representatives from Utah. In 1941, the late Max M. Peet acquired a single specimen of fox sparrow taken 2 miles north of Mount Pleasant, Sanpete County, Utah, on March 17, which, upon comparison with the material in the Dickey Collection, caused the late A. J. van Rossem to express the opinion that it probably represented an undescribed race. Dr. Peet thereupon attempted to assemble specimens from the Utah area so as to work out the problem in collaboration with George M. Sutton, but material in museums was still too scarce to allow them to do so. During the last two years we have succeeded in obtaining considerable material from northern Utah. Following Dr. Peet's death, inquiry was made as to the status of the research. The ornithologists at the University of Michigan Museum graciously told us to go ahead with the problem and sent their comparative material for our use. We are indebted to Drs. J. Van Tyne, Robert W. Storer, and George M. Sutton for this courtesy, and to a number of others as follows for the loan of comparative material: Alden H. Miller, Museum of Vertebrate Zoology; Herbert Friedmann, U. S. National Museum; Robert T. Orr, California Academy of Sciences; Thomas R. Howell, Dickey Collections, University of California at Los Angeles; Kenneth C. Parkes, Cornell University Laboratory of Ornithology; C. Lynn Hayward, Brigham Young University; and Howard Knight, Weber College.

Swarth (Proc. Biol. Soc. Washington **13**: 163.1918), in describing *P. i. canescens*, stressed the gray dorsal color of the birds from the White Mountain region of eastern California in contrast to the brown color of *schistacea*. Now it is disclosed that the birds from Utah are still grayer, so much so that *canescens* looks brown in comparison. Since this is the situation with birds from several locations in the northern part of the state, we feel this extreme gray population is of racial stature and so propose the name

Passerella iliaca swarthi, n. subsp.

Type.—Adult ♂, no. 11451, University of Utah Museum of Zoology, North Fork Ogden River, 5,200 feet, 2 miles west of Eden, Weber County, Utah; April 20, 1951; collected by Robert K. Selander and William H. Behle, original number 1018 (R.K.S.); testes 10 mm.

Subspecific characters.—Distinguished from *P. i. schistacea* by having a decided gray color to the head and back instead of brown; streaking on

breast heavier and less rufescent. Closer to *P. i. canescens* but grayer.

Measurements.—Adult male (32 breeding specimens): Wing, 87.0–76.0 (81.7); tail, 88.2–76.0 (82.4); exposed culmen, 13.3–10.4 (11.8); bill from nostril, 9.6–7.9 (8.6); depth of bill, 10.8–9.0 (9.5); width of bill, 9.2–7.4 (8.2); tarsus, 25.4–21.5 (23.6); middle toe with claw, 23.4–19.4 (20.9); hind toe with claw, 20.0–16.0 (18.6) mm. Adult females (9 breeding specimens): wing, 80.0–74.0 (76.8); tail, 79.3–74.4 (76.8); exposed culmen, 12.4–10.7 (11.6); bill from nostril, 9.2–7.7 (8.4); depth of bill, 10.0–9.0 (9.5); width of bill, 9.0–7.8 (8.2); tarsus, 23.8–22.5 (23.4); middle toe with claw, 24.0–18.6 (20.6); hind toe with claw, 20.8–16.3 (18.7) mm. Measurements were taken according to the methods described by Swarth (Univ. California Publ. Zool. **21**: 83–84. 1920).

Geographic range.—Breeds in northern Utah and southern Idaho. Winter range unknown.

Specimens examined.—Idaho: Owyhee County: Indian Creek, 2 miles southwest of Riddle, 5,500 feet, 1 (June). Bannock County: Pocatello Creek, 3 miles east of Pocatello, 1 (April, toward *schistacea*). Bear Lake County: Paris, 2 (April). *Utah:* Rich County: 12 miles southwest of Woodruff, 1 imm. (July). Cache County: 12 miles west of Garden City, 1 imm. (July). Box Elder County: George Creek near Yost, 6,200 feet, Raft River Mountains, 4 (May); Clear Creek, 3 miles southwest of Nafton, 5 (June). Weber County: North fork of Ogden River, 2 miles west of Eden, 5,200 feet, 12 (April–May). Summit County: Chalk Creek, 5,600 feet, 5 miles east of Coalville, 1 (June); Oakley, 6,500 feet, 2 (May); Kimballs Junction, 6,900 feet, 1 (April). Wasatch County: 3 miles west of Wallsburg, 5,000 feet, 1 (April). Salt Lake County: Salt Lake City, 1 (May); 2–5 miles east of mouth of Emigration Canyon, 2 (April–May); Silver Lake Post Office (Brighton), 8,750 feet, 1 (June). Utah County: Provo, 2 (March–June). Sanpete County: 2 miles north of Mount Pleasant, 1 (March). Tooele County: Lookout Mountain, 1 imm. (July). Juab County: 10 miles northeast of Nephi, 2 (April); head of Basin Creek, 9,500 feet, east slope of Deep Creek Mountains, 6 miles east of Indian Village, 1 (June).

Remarks.—Until the time of Swarth's revision there was confusion concerning the type locality of the race *P. i. schistacea* and some doubt as to which population the name applied. Swarth examined the type specimen and stated (*op. cit.* 154) that it is an adult female in badly molting plumage, of little value for color comparisons, and probably was not breeding at the place where it was collected. This was along the South Platte River in Nebraska, probably between Laramie Crossing and Goodales Crossing approximately 200 miles west of Fort Kearny. There seems little doubt from Swarth's remarks that this represents a distinctly brown bird. He noted a similarity between this type specimen, birds from the Pine Forest Mountains, Nev., and summer birds from the vicinity of Fort Bridger, Wyo. Thus, he conceived of *schistacea* occurring throughout the Great Basin as well as in the interior region to the north.

As new material accumulated it was found that this conclusion was incorrect. Linsdale (Pacific Coast Avif. **23**: 131, 1936) disclosed that the race *canescens* is not confined to the White Mountain region, but extends eastward through Esmeralda County to White Pine County, Nev. Aldrich (Proc. Biol. Soc. Washington **56**: 163–166. 1943) describes the race *olivacea* from Washington. Now it develops that this new race, *swarthi*, occupies the eastern portion of the Great Basin. The range of *swarthi* is not extensive, however, and evidence exists of clines connecting it with *schistacea* to the east, north, and northwest, and probably with *canescens* to the southwest. The southern limits of the range of the species are reached in central Utah so there is no problem of intergradation to the south.

The center of differentiation of this gray population, *swarthi*, appears to be in the Wasatch Mountains of northern Utah. Progressing eastward and northeastward there is evidence of a gradient toward a population with a brown dorsum. A breeding specimen from Chalk Creek, 5,600 feet, 5 miles east of Coalville, Summit County, Utah, is fairly gray, but one from a few miles farther northeast at 3 miles north of the Utah State line on Bear River, 7,450 feet, Uintah County, Wyo., is brown and seemingly transitional toward *schistacea*. A single specimen from Long Lake, head of Ashley Creek, Uintah County, Utah, taken in July, is an immature example, but is in nearly complete first fall plumage. It is too brown for typical *swarthi*, suggesting that the transition to *schistacea* occurs immediately east of the Wasatch Mountains in the Uintah Mountain region of eastern Utah. We have had no material from Colorado available so as to trace this cline farther east.

The birds from Fort Bridger that Swarth had and that we have examined are a puzzling lot.

They are brown and thus similar to *schistacea*, as Swarth noted. This may, however, be attributed to foxing, for the specimens were taken in 1858, and two were evidently once mounted specimens. It may be that fresh material would reveal that the fox sparrows from here are *swarthi*, but it now appears that a rather abrupt transition from *swarthi* to *schistacea* occurs between the headwaters of the Weber and Bear River drainages.

Further evidence of the transition to *schistacea* is seen in the two August specimens from Bear Lake County in southeastern Idaho which are slightly browner than topotypical examples of *swarthi* and so intergradational. A mid-August example from Afton, Wyoming, a specimen from Teton Mountain taken on August 28, and one from Teton Pass, September 11, are all referable to *schistacea*.

To the northwest, a series of breeding examples from the Raft River Mountains are closer to *swarthi* but are slightly browner than topotypical specimens. This again indicates the beginnings of a character gradient toward *schistacea*. A specimen from Pocatello Creek, Bannock County, Idaho, is almost exactly intermediate between the two races. Although taken April 2, it had testes 8 mm long and was probably on its breeding ground. It is arbitrarily placed with *swarthi*. North of this location, the fox sparrows are closer to *schistacea* which probably exists in typical form in northern Idaho. Examples from Idaho that we have examined which are referable to *schistacea* are as follows: Cottonwood Creek, 2 miles west of Craters of the Moon, Blaine County (July); Glidden Lakes, 5,700 feet, Shoshone County (July); Beaver Ridge, 6 miles south southwest Lolo Pass, 6,000 feet, Idaho County (July); Coeur d'Alene, Kootenai County (April–May); Hunt Peak, Selkirk Mountain, Boundary County (August). Also referable to *schistacea* are specimens from the Wallowa Mountain area in southeastern Oregon, the specific localities being 16 miles south and 3 miles east of Lostine, 5,500 feet, Wallowa County (July) and North Fork of the Malheur River, 15 miles east and 12 miles south of Prairie City, 5,100 feet, Baker County, Oregon (July).

Apparently *swarthi* gives way to *schistacea* as one proceeds westward across northern Nevada. A single worn specimen taken July 15 at Cedar Creek, 6,000 feet, 10 miles northeast of San Jacinto, Elko County, is like specimens of the series from the Raft River Mountains and is probably closer to *swarthi*. Three breeding birds and several taken in September from the Santa Rosa Mountains, Humboldt County, farther to the west, are brown and thus referable to *schistacea*. They are very similar to those from the Pine Forest Mountains still farther west.

While our principal concern has been to show that these specimens from central northern and northwestern Nevada are not *swarthi*, it may not be amiss to call attention to the problem in connection with the birds of northern Nevada. Although Swarth referred the Pine Forest Mountain series to *schistacea*, he noted differences between them and examples from the Banff (Canada) region. The chief difference is that birds from the latter locality have shorter tails (see Swarth, Univ. California Publ. Zool. **21**: 155, 182. 1920). He suggested that either the Banff birds are from an area of intergradation between *schistacea* and *altivagans*, with the birds from northern Nevada being truly representative of *schistacea*, or the short tailed, small billed, rufescent northern birds represent true *schistacea*, and the birds from northern Nevada belong to another race. This problem still remains undecided, and until much more material is available to bridge the intervening areas, the Pine Forest series is best referred to *schistacea*, as both Swarth and Linsdale have done.

In Swarth's table of measurements (*op. cit.* 182–183), a series of six male specimens, presumably adults, of the race *canescens* has a shorter length of bill than do series of *schistacea*. Thirty breeding male specimens of *canescens* from Esmeralda, Nye, and Lander Counties, Nev., were measured by us with results as follows: Wing, 83.3–77.1 (81.4); tail, 86.2–75.6 (80.9); exposed culmen, 12.3–10.0 (11.2); bill from nostril, 9.4–7.6 (8.5); depth of bill, 10.0–8.4 (9.3); width of bill, 8.8–7.6 (8.2); tarsus, 25.8–20.2 (23.3); middle toe with claw, 23.0–17.5 (20.4); hind toe with claw, 19.8–16.0 (18.0) mm.

This lot of *canescens* and our series of *swarthi* are therefore comparable in size, and furthermore, they are essentially the same size as the Pine Forest Mountain series representing *schistacea*. It was noted that the immature specimens in the topotypical series of *canescens* have smaller bills than do the adults. Nine adult male topotypes or near topotypes of *canescens* have the following measurements: exposed culmen, 11.7–10.3 (11.3); bill from nostril, 9.0–7.8 (8.3); depth of bill, 10.6–9.0 (9.6); width of bill, 8.8–8.3 (8.5) mm.

This further corroborates the lack of significant differences in size of bill between the three races, *canescens*, *swarthi* and *schistacea*.

The material available is inadequate for working out the details of the transition between *swarthi* and *canescens*, which probably takes place in the mountains of central eastern Nevada between the Snake and Toyabe Mountains. A single breeding specimen from the Deep Creek Mountains in extreme western Utah is referable to *swarthi*. In addition to a gray dorsum it has an unusually heavily marked breast with dark, slate colored blotches. A single specimen from the Snake Range in Nevada, a short distance to the south of the Deep Creek Mountains, taken September 22, is brown and referable to *schistacea*. It was, however, probably a transient. Breeding birds from Kingston Creek in the Toyabe Mountains are brown and thus represent *canescens*. The distribution of the races of fox sparrows in Nevada remains, then, as Linsdale (*op. cit.*) has indicated, except that the breeding birds of the Snake Range probably represent *swarthi*.

Some other examples of fall transients of *schistacea* from the breeding range of *swarthi* are two from 4 miles northeast of Ogden, 8,000 feet, taken September 22 and 29. Several early April atypical examples of *swarthi* are probably transients from areas of intergradation between that race and *schistacea*.

The places of occurrence and ecological relationships of fox sparrows of the race *swarthi* are essentially as Linsdale (Amer. Midl. Nat. **19**: 167–170. 1938) described for the race *canescens* in the Toyabe Mountains of Nevada, thus being further indicative of the close relationship between *canescens* and *swarthi*.

ZOOLOGY.—*Two new species of incrusting ctenostomatous Bryozoa from the Pacific.*[1]

JOHN D. SOULE, Allan Hancock Foundation, Los Angeles, Calif. (Communicated by Waldo L. Schmitt.)

Examination of specimens dredged recently from the Arctic Ocean off Point Barrow, Alaska, by the Arctic Research Laboratory and off the coast of southern California by the Allan Hancock Foundation has revealed two species of ctenostomatous bryozoans of the group Carnosa which are believed to be new.

Family ALCYONIDIIDAE Hincks, 1880

Alcyonidium enteromorpha, n. sp.

Diagnosis.—Zoarium robust, coriaceous, linear, flexuous, measuring 61 cm in length and 4 to 6 mm in width, anchored directly to the substratum without evidence of a peduncle. Cuticle moderately thick. Zooecia irregular, ranging in shape from rectangular to hexagonal. No raised oral papillae. Polypide with 17 tentacles.

Description.—Macroscopically the chitinous, leathery zoaria superficially resemble the intestinal tract of a small mammal, being unusually elongate, without lateral branching. Coiled in several loose folds, gutlike, and attached to the substratum without the benefit of a peduncle. The cuticle is firm, mottled light brown to tan, and only moderately thick. The zoaria have a central cavity filled with a loose reticular packing tissue in which may be found numerous brown-bodies. The zooecia are well defined, easily found in the portions of a zoarium where the cuticle is thin. However, on the greater part of a zoarium the lateral zooecial walls can be only faintly discerned, and while not totally obscured they are somewhat difficult to trace. The ventral zooecial wall is smooth with no oral papillae present. The dorsal wall is thin to the point of transparency. In shape the zooecia are quite variable, ranging from rectangular to irregularly hexagonal, those containing mature polypides measuring between 230μ to 403μ in length, and 115μ to 253μ in width. The polypide itself in no way deviates morphologically from the normal anatomical pattern typical of the genus *Alcyonidium* s.s. The tentacle number determined by serial sections is 17. Whole mounts of several individual polypides, as well as sections, were prepared, stained and examined for evidence of a gizzard. Polypides of *A. polyoum* (Hassall) and *A. pedunculatum* Robertson were mounted for purposes of comparison.

The species described above differs from *Alcyonidium* (*Paralcyonidium*) *vermiculare* Okada, 1925, in the following ways: (1) The zoarium is larger, with a uniform width of 4 to 6 mm as against 2 to 3 mm for *A. vermiculare;* (2) the polypide does not have a gizzard, as is described for *A. vermiculare;* (3) the tentacle number is

[1] Contribution no. 63 from the Allan Hancock Foundation, University of Southern California.

17 as against 20 found in *A. vermiculare*. It differs from *Alcyonidium pedunculatum* Robertson, 1902, by virtue of its extreme zoarial length and its lack of a peduncle.

Types.—Holotype: U. S. N. M. no. 10981. Paratypes in the Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.

Type locality.—Off Point Barrow, Alaska; August 17, 1949, 12.1 miles out, depth 741 feet. Collector, G. E. MacGinitie, Arctic Research Laboratory.

Additional distribution.—Off Point Barrow, Alaska, September 6, 1949, depth 477 feet. Same collector.

Family FLUSTRELLIDAE Hincks, 1880

Genus **Pherusella,** n. name

In 1816 Lamouroux erected the genus *Pherusa* into which he placed the *Flustra tubulosa* of Solander, 1786. However, it has since been found that *Pherusa* Lamouroux, 1816, is a homonym of *Pherusa* Oken, 1807. The name *Pherusa* has also been used by Leach, 1814, Crustacea, and by Rafinesque, 1815, Mollusca. In 1887, Pergens also used the name *Pherusa* for Bryozoa but without descriptions or figures.

Since the *Pherusa* of Lamouroux is unquestionably preoccupied, it is therefore necessary to introduce a new name, and also to redefine and amend the description published by Lamouroux. The original description by Lamouroux, 1816, is as follows: "Pheruse. *Pherusa*. Polypier frondescent, multifide; cellules oblongues et saillantes sur une seule face; ouverture irregulière; bord contourné."

Zoaria coriaceous, incrusting, or from incrustations arising in branching flabellate projections.

Zooecia elongate, rectangular to hexagonal with zooecial walls well defined. The distal ends of the zooecia rise into prominent tubular projections, bearing upon the upper ends the apertures which, when the polypide is retracted, appear square to transversely quadrangular in shape. The length of this tubular projection is relatively constant within a species.

The ventral wall is generally smooth. The lateral walls of the zooecia are characterized by interzooecial communication pores. These pores are very distinct, owing to the presence of heavy chitinous rims, which are a dark brown in contrast with the tan color of the walls. When examined from the dorsal aspect, these pores form a regular pattern following the zooecial borders.

In the generic description by Lamouroux it is stated that the apertures were found on one surface only. Bilaminar, back to back, specimens, as well as unilaminar specimens, have been found in erect zoaria when the growth of the zoaria exceeds the limits of the algae upon which they are incrusted. Thornely (1905, p. 127) observed this type of growth on *P. tubulosa* collected in Asiatic waters.

Pherusella tubulosa (Solander), 1786, not represented at this time in the eastern Pacific collections, the sole species for over a hundred years, is the genotype. The genus now includes *Pherusella tubulosa* (Solander), 1786, *Pherusella flabellaris* (Kirkpatrick), 1890, and the new species described below. *Alcyonidium flustrelloides* Barroso, 1920, is a junior synonym of *P. tubulosa*.

Pherusella brevituba, n. sp.

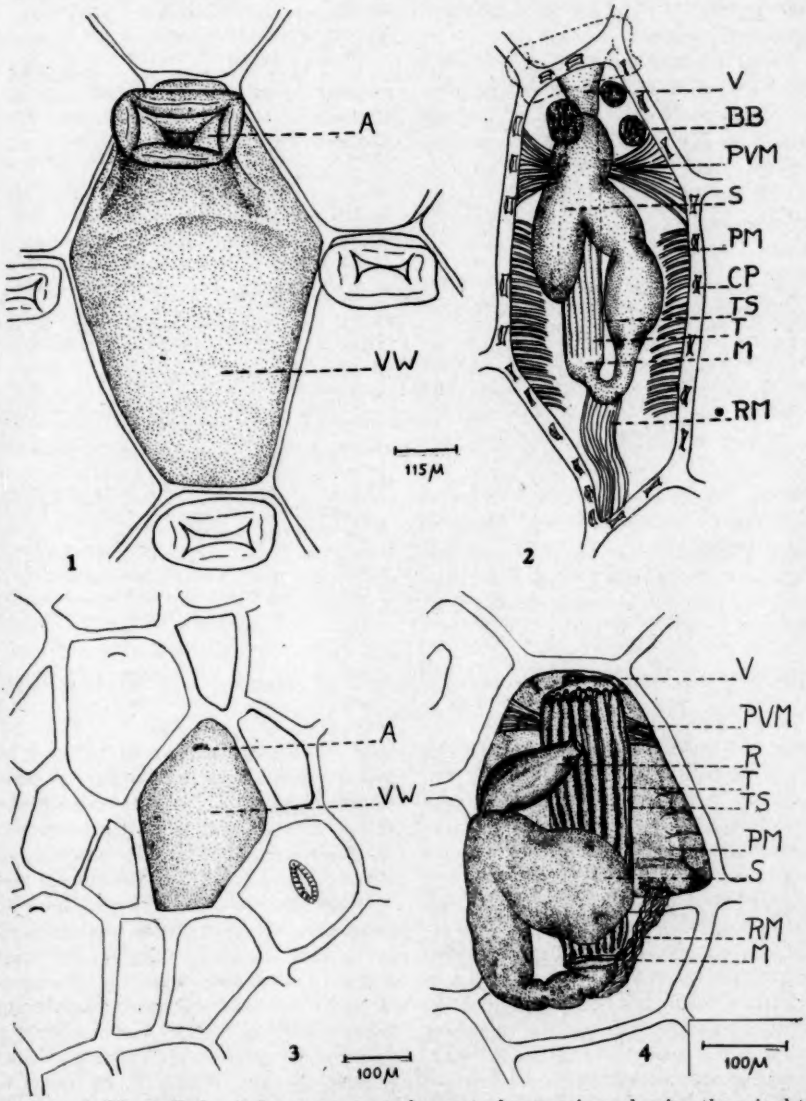
Diagnosis.—Zoaria chitinous, incrusting or arising from an incrustation in wide, flat, flabellate expansions, which measure up to 6.0 cm in height and from 1.5 to 2.5 cm in width. Zooecia are distinct, elongate, variable in shape from an irregular rectangle to a hexagon. The lateral zooecial walls are perforated by interzooecial communication pores which have a distinct chitinous ring. The aperture is borne on a distally located, raised tubular prominence whose upper extremity is square or transversely quadrangular when the polypide is retracted. This tubular projection is short, rising only 250μ to 300μ in height. Tentacles number 23.

Description.—The zoaria are a light brown in color, chitinous, leathery in appearance, and form heavy incrustations upon the holdfasts and blades of algae. When the zoaria are strictly incrusting they are unilaminar, or they may form erect fanlike fronds that are bilaminar, back to back, where the zoarial growth exceeds the limits of the algal thalli.

The zooecia are elongate with considerable variation in shape from imperfectly rectangular to hexagonal, averaging about 800μ in length and 400μ in width. Normally the individual zooecia are distinct, clearly defined by the lateral walls. The lateral walls are perforated by well-marked interzooecial communication pores whose diameter averages 27μ. By examining the zooecia from the dorsal side in a unilaminar zoarium, or by careful focusing on a bilaminar zoarium, these

communication pores will be seen to form a regular pattern on the lateral walls of the zooecia. The rims of the communication pores are strengthened by heavy chitinous rings. Within this ring are four minute perforations piercing a thin chitinous diaphragm.

The distal portion of each zooecium is raised to form a short but prominent tubular process



FIGS. 1–4.—1, *Pherusella brevituba*, n. sp., ventral aspect of a zooecium, showing the raised tubular projection bearing the aperture; 2, same, dorsal view, drawn from an unilaminar zoarium, showing the anatomy of the polypide within a zooecium; 3, *Alcyonidium enteromorpha*, n. sp., ventral aspect of a portion of a zoarium; 4, same, dorsal view, showing the anatomy of a polypide within a zooecium. (A, aperture; BB, brown-body; CP, communication pore; M, mouth; PM, parietal muscle; PVM, parieto-vaginalis muscle; R, rectum; RM, retractor muscle; S, stomach; T, tentacle; TS, tentacle sheath; V, vestibule; VW, ventral wall.) Drawings by Dorothy F. Soule.

which bears the aperture. When the polypide is withdrawn into the zooecium this tubular projection appears square to transversely quadrangular. When the polypide is extruded the tentacle sheath further extends the reach of the tentacles. The tentacles were found to consistently number 23 in sectioned material.

The new species is distinguished from *P. tubulosa* (Solander), 1786, by its short tubular processes and its tentacle number. In *P. tubulosa* the tentacle number is 28 (Prouho, 1892). It is distinguished from *P. flabellaris* (Kirkpatrick), 1890, which like Solander's species has lengthy tubular processes 0.6 mm in height, but has only 20 tentacles.

Holotype.—AHF no. 55. Colony incrusted upon the holdfast and blades of *Halidrys* sp.? (marine alga).

Type locality.—Hancock Foundation station 1909–49, east of Portuguese Bend, Calif., lat. 33° 43′ 00″ N., long. 118° 19′ 57″ W.; 8 to 7.5 fathoms; bottom rocky, November 6, 1949; collector, J. D. Soule.

Additional distribution.—(1) Santa Barbara–San Luis Obispo County line; washed ashore on holdfast of *Halidrys;* August 2, 1939; collector, A. Sorensen. (2) Punta Baja, near Rosario, Baja California, tide pool; substratum unknown; April 9, 1946; collector, E. Y. Dawson.

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ZOOLOGY.—*The number of species of decapod and stomatopod Crustacea.*[1] FENNER A. CHACE, JR., U. S. National Museum.

As part of a collaborative effort to list the number of species belonging to each of the major groups of the Animal Kingdom for a proposed biological handbook, a fairly intensive survey was made of the Recent species of shrimps, lobsters, anomurans, crabs, and mantis shrimps. No such count of the decapod crustaceans seems to have been attempted in the past. It may be useful, therefore, to present the results of this survey in more complete form than they will appear in the handbook and to indicate the measures taken to insure a reasonably accurate coverage of the higher crustaceans.

The files on decapod and stomatopod crustaceans in the U. S. National Museum are unusually valuable for a survey of this kind because of continued interest in the groups by one or more members of the staffs of the division of marine invertebrates for well over half a century. A systematic card catalogue expanded and amended from entries in the Zoological Record was used as the basis for the compilation. This was supplemented by reference to published generic revisions; to extensive unpublished notes and species lists which were initially accumulated by Dr. Mary J. Rathbun during her many years of active carcinological work and which have been continued and expanded by Dr. Waldo L. Schmitt; to an invaluable manuscript synonymy of the caridean shrimps compiled by Dr. L. B. Holthuis, of the Rijksmuseum van Natuurlijke Historie, Leiden, Holland; and to a manuscript summary of the crayfishes

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of the world prepared by Dr. Horton H. Hobbs, Jr., of the Miller School of Biology, University of Virginia. Because of the lack of published revisions of a large proportion of the decapod genera, the results of this review would be very much less significant without the contributions of these four carcinologists.

As there is still a lag of several years between the appearance of scientific papers and their abstraction by the Zoological Record and as the disruption in the exchange of publications caused by the last world war has not yet been completely remedied, only those species described through the year 1945 have been counted. In general, only full species are included, although it must be admitted that a large number of crustacean subspecies and varieties will be elevated to specific rank when relationships become better known. It is of course impossible to arrive at definitive counts for most invertebrate groups. Differences of opinion as to the validity of many genera and species will persist until more complete collections are available for study and more workers have had an opportunity to review the evidence.

The classification in the following table follows the system accepted by most carcinologists today. There has been some criticism from workers in other groups of the use of the "tribe" as a superfamilial category. Justifiable though this criticism may be, it is felt that any change in the generally accepted classification of the Crustacea should await an over-all revision of that entire complex class. The subtribes and superfamilies have been intentionally omitted because of the lack of agreement about the limits of several of them and not because of any belief that they are not desirable for an understanding of decapod relationships.

NUMERICAL DISTRIBUTION OF THE RECENT GENERA AND SPECIES OF DECAPOD AND STOMATOPOD CRUSTACEA

	Genera	*Species*
ORDER DECAPODA	1,001	8,321
Suborder Natantia (shrimps)	211	1,930
Tride Penaeidea	33	318
Family Penaeidae	27	231
Family Sergestidae	6	87
Tribe Caridea	171	1,590
Family Pasiphaeidae	7	60
Family Stylodactylidae	1	7
Family Atyidea	21	137
Family Oplophoridae	6	54
Family Nematocarcinidae	1	17
Family Bresiliidae	2	2
Family Disciadidae	1	3
Family Processidae	2	15
Family Pandalidae	14	112
Family Thalassocaridae	1	2
Family Psalidopodidae	1	3
Family Crangonidae	20	399
Family Hippolytidae	28	200
Family Rhynchocinetidae	1	7
Family Campylonotidae	2	6
Family Palaemonidae	46	380
Family Gnathophyllidae	4	13
Family Glyphocrangonidae	1	35
Family Cragonidae	10	136
Family Eugonatonotidae	1	1
Family Physetocaridae	1	1
Tribe Stenopodidea	7	22
Family Stenopodidae	7	22
Suborder Reptantia	790	6,391
Tribe Palinura	16	123
Family Eryonidae	2	39
Family Palinuridae (spiny lobsters)	8	35
Family Scyllaridae (Spanish lobsters)	6	49
Tribe Astacura	25	313
Family Homaridae (lobsters)	7	32
Family Austroastacidae (crayfishes)	1	2
Family Parastacidae (crayfishes)	10	76
Family Astacidae (crayfishes)	7	203
Tribe Anomura	114	1,527
Family Aeglidae	1	20
Family Chirostylidae	3	69
Family Galatheidae	6	258
Family Porcellanidae	17	225
Family Axiidae	9	84
Family Axianassidae	1	2
Family Laomediidae	3	6
Family Callianassidae (mud shrimps)	6	160
Family Thalassinidae	1	5
Family Pylochelidae	5	17
Family Paguridae (hermit crabs)	38	555
Family Coenobitidae (hermit crabs)	2	17
Family Lithodidae (king crabs)	15	53
Family Albuneidae	4	31
Family Hippidae	3	25
Tribe Brachyura (true crabs)	635	4,428
Family Raninidae	10	30

	Genera	*Species*
ORDER DECAPODA—Continued.		
Suborder Reptantia—Continued.		
Family Homolodromiidae	4	6
Family Dromiidae	18	156
Family Dynomenidae	2	13
Family Thelxiopeidae	6	16
Family Latreillidae	3	9
Family Hapalocarcinidae (coral gall crabs)	3	12
Family Dorippidae	10	77
Family Calappidae (box crabs)	10	65
Family Leucosiidae (purse crabs)	40	338
Family Euryalidae	6	14
Family Portunidae (swimming crabs)	38	297
Family Potamonidae (freshwater crabs)	13	520
Family Atelecyclidae	13	30
Family Cancridae (rock crabs)	2	22
Family Xanthidae	133	928
Family Goneplacidae	54	170
Family Pinnotheridae (pea crabs)	26	222
Family Retroplumidae	1	4
Family Cymopoliidae	3	39
Family Grapsidae	40	333
Family Gecarcinidae (land crabs)	6	20
Family Ocypodidae (ghost crabs, fiddler crabs)	19	231
Family Hymenosomidae	9	53
Family Majidae (spider crabs)	145	673
Family Parthenopidae	21	150
Order Stomatopoda	8	178
Family Squillidae (mantis shrimps)	8	178

The total of approximately 8,321 recognized species of decapods agrees almost exactly with the estimate of "over 8,000 living species" cited by Pratt in 1935.[2] However, the numbers of genera and species assigned by Pratt to several of the subordinal groups do not correspond as closely with the figures in the preceding table.

The Decapoda make up by far the largest order of the Crustacea; very nearly one-third of the accepted recent crustaceans belong to this group. It is likely that the number of species of decapods will increase by 30 or 40 percent when all living forms are recognized. Some of the other crustacean groups which have received attention for shorter periods of time possibly contain more undescribed species, but the position of the decapods as the largest and most diversified order of the class will probably never be seriously challenged.

It may be of interest that the number of decapods now known approximates Mayr's count of the number of full species of birds (8,616).[3] The numbers of bird families (160) and genera (1,800–2,600), however, are fully twice as large as those of the decapods. The average genus of birds therefore contains only 3.3 to 4.75 species, whereas the average decapod genus is made up of 8.3 species. This discrepancy probably does not reflect any great dissimilarity between the specific relationships of birds and decapods. Because of the extreme diversification of the decapods, it would seem safe to assume that intense systematic attention to that group, similar to that which has been focused on birds for so long, would result in an even larger proportionate number of families and genera among the decapods than among the birds.

[2] PRATT, H. S., *A manual of the common invertebrate animals exclusive of insects*, rev. ed.: 447–467. 1935.

[3] MAYR, ERNST, *The number of species of birds*. Auk **63**: 64–69. 1946.

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